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HANDBOOK ON SANITATION OF VESSEL CONSTRUCTION

Public Health Service
Washington, D. C.

1965

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HANDBOOK
ON SANITATION OF

Vessel Construction

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service

PB 215 875

HANDBOOK ON SANITATION OF

Vessel Construction

STANDARDS OF SANITATION
AND RATPROOFING FOR THE
CONSTRUCTION OF VESSELS

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Public Health Service

Bureau of State Services

DIVISION OF ENVIRONMENTAL
ENGINEERING AND FOOD PROTECTION

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PREFACE

Set forth in this handbook are minimum public-health standards relating to general sanitation and ratproofing in the construction of vessels. These standards have been developed over a period of several decades; experience has shown that their observance during construction, reconstruction, or major repair, will make it much easier to maintain the vessels in an acceptable, sanitary condition during operation.

Provisions of this edition apply to vessels contracted for after January 1, 1966. Prepared by the Interstate Carrier Branch, Division of Environmental Engineering and Food Protection of the Public Health Service, Department of Health, Education, and Welfare, this Handbook supersedes the publication *Handbook on Sanitation of Vessel Construction*, dated 1957. The standards contained herein are essentially the same as those included in the former publication, but appropriate revisions have been made in recognition of operating experiences, technological advancements, and changes in the Interstate Quarantine Regulations. Advice was requested from naval architects, shipbuilders, vessel owners and operators, industrial suppliers, and other Government agencies. Their suggestions and comments have made it possible to produce a more practical handbook.

Improved methods and equipment, undoubtedly will be developed from time to time. It is the policy of the Public Health Service to request that individuals, whose disciplines are closely associated with vessel design and construction, provide information and advice on technological developments which can affect shipboard sanitation. From time to time, as the health significance of these items is evaluated and as circumstances permit, improved methods and new topics will be included in revisions of this publication. Such developments will lead to changes in existing standards of sanitation for vessel construction. This handbook will be revised accordingly, as circumstances may require.

This publication is one of two handbooks dealing with vessel sanitation. The other, entitled *Handbook on Sanitation of Vessels in Operation*, PHS Publication No. 68, was revised in 1963.

Vessel plans should be submitted for review of their sanitation features. Two copies should be sent to: Chief, Interstate Carrier Branch, Division of Environmental Engineering and Food Protection, Public Health Service, Department of Health, Education, and Welfare, Washington, D.C., 20201.

Inquiries regarding this vessel sanitation program and this handbook should be directed to the appropriate Regional Office listed inside the back cover.

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HANDBOOK ON SANITATION OF VESSEL CONSTRUCTION

Section A. POTABLE WATER SYSTEM

1. GENERAL. The term *potable water*, as used herein, means water which meets the requirements of the Public Health Service Drinking Water Standards.[1]

Whenever practicable, only one water system should be installed, supplying potable water for drinking, cooking, dishwashing, ablutionary, hospital, and laundering purposes. Where dual systems must be installed, potable water should be piped to outlets where it may be used for drinking cooking, dishwashing, or medical-care purposes (exclusive of hydrotherapy), but it need not be piped to slop sinks, lavatories, laundry facilities, bathtubs, showers, water closets, bidets, and hose connections used for deck washing purposes. Only potable water should be supplied to food preparation spaces except as note in section E, item 10.

Water for potable purposes should be obtained from acceptable watering points. When purification or treatment on board is necessary, the method selected for use should be that which is best suited to the water and most easily understood by the operating personnel. All parts of the potable water system should be located so they will not be submerged in bilge water (a minimum of 18 inches above the bilge level), nor pass through tanks storing nonpotable liquids.

2. FILLING HOSE. A special hose should be provided for loading potable water from shore sources, except on vessels where distillation or other treatment process is used to provide potable water and where shore sources are never used. The hose should be durable, should have a smooth, impervious lining, and should be equipped with the necessary fittings for fastening it to the filling line and the hydrant. It is preferable that the fittings and threads be different from those on other hoses on the vessel, and suitable adapters for connecting these fittings to hydrants should be provided. For vessels whose specific needs are not known, at least two 50-foot sections should be

[1] Subpart J of the Interstate Quarantine Regulations, as amended.

provided. The potable water filling hose should be clearly marked with one-inch (minimum) lettering reading POTABLE WATER HOSE ONLY. All potable water hose adapters should be properly identified.

3. FILLING-HOSE STOWAGE. The potable water hose and such hydrant adapters as may be required should be stowed in a self-draining closet cabinet or on a rack or reel, or hung on brackets and located near the vessel's filling line connection. These facilities should be installed at least 18 inches above the deck and used for no other purpose. When the hose is stowed on a rack or reel or hung on brackets, means should be provided to secure the hose to its supports or to the bulkhead. A hose which is not stowed in a closed cabinet should have its ends capped with threaded fittings. The hose cabinet or stowage space should be permanently marked by means of ½-inch lettering (minimum) on a noncorrosive label plate, or equivalent, reading POTABLE WATER HOSE ONLY.

4. FILLING LINE. A potable-water tank system which may be filled by hose should have an independent filling line which should not be cross-connected with any line of a nonpotable system, and should not pass through any nonpotable liquid.

The filling line should begin, either horizontally or in a gooseneck pointing downward, at a point at least 18 inches above the top of the tank or of the deck which the line penetrates. Screw threads, or other devices permitting hose attachment on the end of the potable-water filling line, preferably should be different from the threads or devices on other filling lines and on fire hydrants. The filling line should have a screwcap or plug fastened by a chain to an adjacent bulkhead or surface in such a manner that the cap or plug will not touch the deck when hanging free. Each filling line should be clearly marked by means of ½-inch lettering (minimum) stamped on a noncorrosive label plate, or equivalent, and located at or near the point of hose connection reading POTABLE WATER FILLING. The filling line within the vessel should be painted or stenciled, as recommended in section A, item 15.

5. STORAGE CAPACITY. Adequate storage should be provided for potable water. In determining the amount, consideration should be given to the size of the crew, the maximum number of passengers to be accommodated, the frequency with which water can be loaded from acceptable sources, the availability of water suitable for treatment and facilities for treating it, and the types of water systems aboard.

The consumption values given in table I, below, are intended merely as guides for the amount of storage required. The actual unit values will depend upon the type of vessel and the service in which it is engaged. Present design practice exceeds this amount for a combined system.

TABLE I.—*Approximate minimum rates of consumption of domestic water on vessels*

Item	Gallons per person per day		
	Drinking-cooking system	Wash-water system	Combined system
Drinking water:			
Crew, passengers	0.7		0.7
Cooking water:			
Cooking, vegetable and fruit washing	0.8		0.8
Dishwashing	5.0		5.0
Washing:			
Baths		16.0	16.0
Lavatory		5.0	5.0
Laundry		1.0	1.0
Cleaning in galley, pantry, and dining room	1.5		1.5
Total	8.0	22.0	30.0

The amount of storage may be decreased when the potable-water supply will be supplemented with water purified aboard, but only by such an amount as can be supplied dependably by the purification process.

When the entire potable-water supply is obtained by distillation of overboard water, or by acceptable treatment of overboard fresh water, sufficient storage should be provided to preclude the need for treating overboard water from harbors or other heavily contaminated areas, and to provide for periods of maintenance and repair. The treatment of water from heavily contaminated areas can be avoided by loading from acceptable shore sources while in port, or by the treatment of water from wash-water tanks which have been filled from satisfactory sources. In the latter case, total storage requirements can be made up of a combination of wash-water storage and potable-water storage, but in no case should the potable-water storage be less than a 2-day supply.

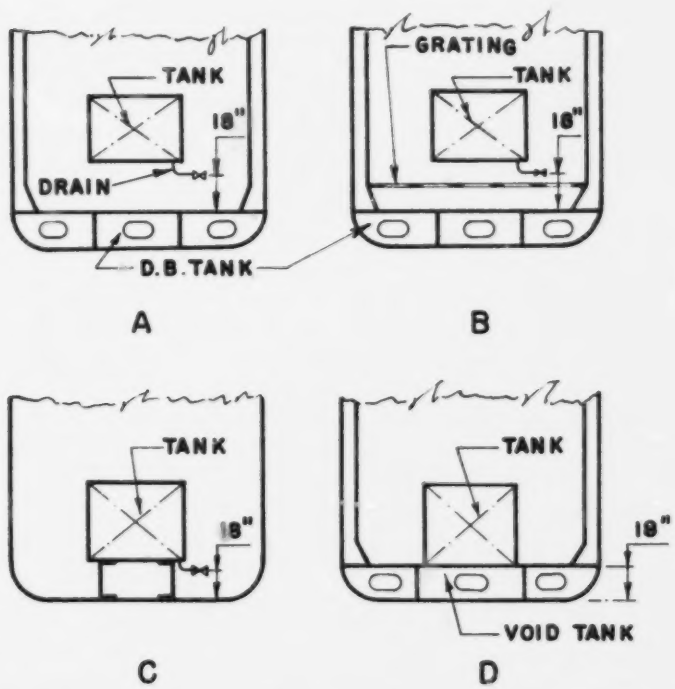
6. STORAGE TANKS. Potable water should be stored in one or more tanks which are so constructed, located, and protected as to be safe against any contamination from the outside. Such a tank should be constructed of metal or other suitable material. It should be independent, with no common boundary with a tank holding nonpotable water or other liquids. The tank should be independent of the shell of the ship, unless the bottom of the tank is at least 2 feet above the maximum-load waterline, and all shell seams and connections in way of the tank are continuously welded on the inside of the tank. There should be no rivets in that part of the shell or shell connections which form the side of the tank. No through-bolts should be used in or on potable water tanks.

A deck may be used as the top of a potable-water tank, provided that there are no access or inspection openings therein, and that the seams are continuously welded on the inside of the tank. There should be no rivets or bolts in that part of the deck which forms the top of the

tank. No toilet or urinal should be installed over that part of a deck which forms the top of a potable-water tank. A deck may form the bottom of a potable-water tank, provided that it does not also form the top of a tank which holds nonpotable water or other liquids.

The bottom of any potable-water tank in the lower part of the ship should be located so that the tank drain is at least 18 inches above the top of inner-bottom tanks used for the storage of liquids (see fig. 1). When an operating deck, platform, or grating is installed in the vicinity of the potable-water tank and near the inner-bottom plating, it is preferable that the bottom of the potable-water tank be above such operating deck, platform, or grating (see fig. 1B). In the absence of inner-bottom plating, the bottom of the potable-water tank drain should be at least 18 inches above the lowest point of the bilge space. The bottom of a potable-water tank may be formed by the inner-bottom plating provided that:

a. An 18-inch-deep void space exists underneath; and
b. There is no way for the void to be filled; and



ACCEPTABLE LOCATION OF POTABLE WATER TANKS IN RELATION TO BILGE OR INNER BOTTOM TANKS

Figure 1

treatment of water drawn from those tanks before its use as potable water.

7. STORAGE TANK VENTS. Potable water storage tanks should be provided with a vent so located and constructed as to prevent the entrance of contaminating substances. A single pipe without takeoffs may be used as a combined vent and overflow. A potable water tank vent should not be connected to the vent of any tank holding or intended for holding nonpotable liquid. The vent or combined vent and overflow should terminate with the open end pointing downward and should be screened with 16-mesh corrosion resistant wire. It should terminate a minimum distance of 18 inches above the deck. When the end is exposed to wave action, it should be equipped with a backwater (check) valve.

8. STORAGE TANK OVERFLOWS. The potable water tank should be provided with an overflow, or relief valve, which should be so located that the test head of the tank is not exceeded. The overflow should be constructed and protected in the same manner as recommended for vents in item 7. An overflow may be combined with a vent, but the provisions described for the construction and protection of both vents and overflows should be observed.

9. STORAGE TANK MANHOLES. The potable water tank should be provided with a manhole, to provide access into the tank for cleaning purposes. The manhole should be located in the side, but may be in the top when the top is not formed by a deck. When located in the top, it should be provided with a coaming, or curb, raised at least one-half inch above the tank-top. The cover should extend to the outer edge of the curb or flange, and should be provided with a gasket and a device for securing it in place. Flush manholes will be acceptable in the sides of tanks.

10. WATER-LEVEL GAUGES. Any means provided for determining the depth of water in the potable-water tanks should be so constructed as to prevent the entrance of contaminated substances or liquids into the tanks.

Devices which are considered satisfactory for determining the water level in a potable-water tank include, but are not restricted to:

a. Water-gauge glass with shutoff valve on a side of the tank.

b. Petcocks at appropriate intervals on the side of the tank.

c. Petcocks installed in a vertical, offset pipe which is connected to the tank near the bottom and top.

d. Water-level indicators actuated by air pressure. (The air may be supplied by a handpump, or an independent compressor, or through a "press-on" valve with a liquid trap installed in the supply line from the main compressed-air system.)

e. An enclosed float gauge.

f. A water-operated pressure gauge.

11. TANK DRAINS. The potable-water tank should be so designed that it can be completely drained. The drain opening should be of at least one and one-half inch diameter. When drainage is by gravity flow, the opening should be in the bottom of the tank and should terminate flush with, or below the inner surface of the tank bottom. The installation should be such as to avoid a reinforcing plate, a raised welding bead, or a protruding pipe in way of the hole, which would prevent complete drainage. This can be accomplished as shown in figure 3. When the potable-water-pump suction line is used to drain the tank, it should drain from a sump, as shown in figure 3C. A drain in the discharge line should be located ahead of any branch takeoff to the distribution system. A valve should be installed on the main immediately beyond the drainline takeoff.

A screwplug or capped nipple should be installed on a tank drain only where it is easily accessible and where the water can be wasted directly therefrom. When a pipe drainage system is installed, it should be independent of all other drainage systems, and should be protected as specified in section G, item 6. The drainline should be plugged or capped, to prevent the loss of water in case the drain valve should become loosened by vibration, unless a locking-type valve is provided.

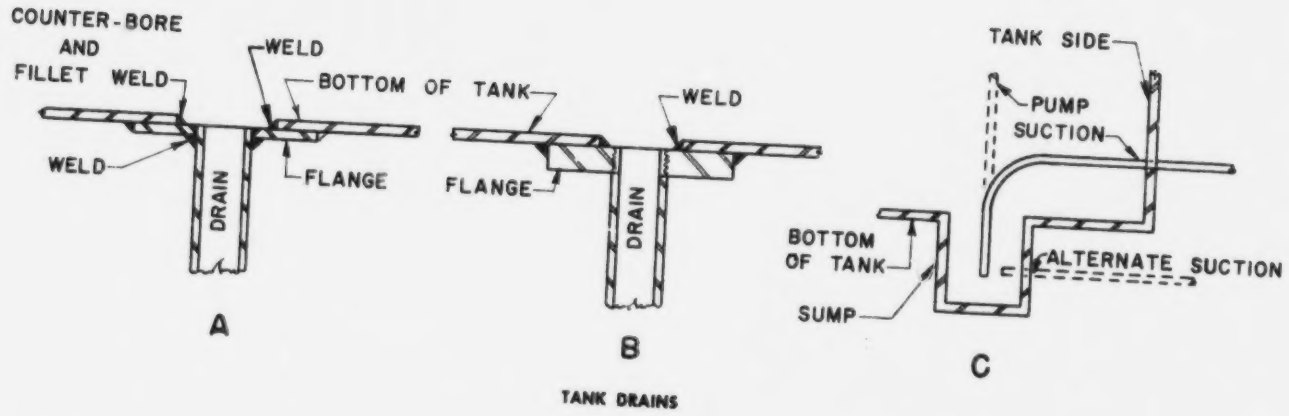
12. DISTRIBUTION SYSTEM. The distribution lines, including the suction lines of the potable-water pump, should not be cross-connected with the piping or storage tank of any nonpotable-water system. There should be no blind or spectacle flanges, nor any removable or swing sections of pipe in the lines, whereby such a connection can be made.

The distribution lines, including the suction lines of the potable water pump, should be located so they will not be submerged in bilge water, (see section G, item 6) nor pass through tanks storing nonpotable liquids, without benefit of an acceptable, self-draining tunnel.

The distribution system should be protected against the introduction of contamination by backflow, as specified in section G, item 6.

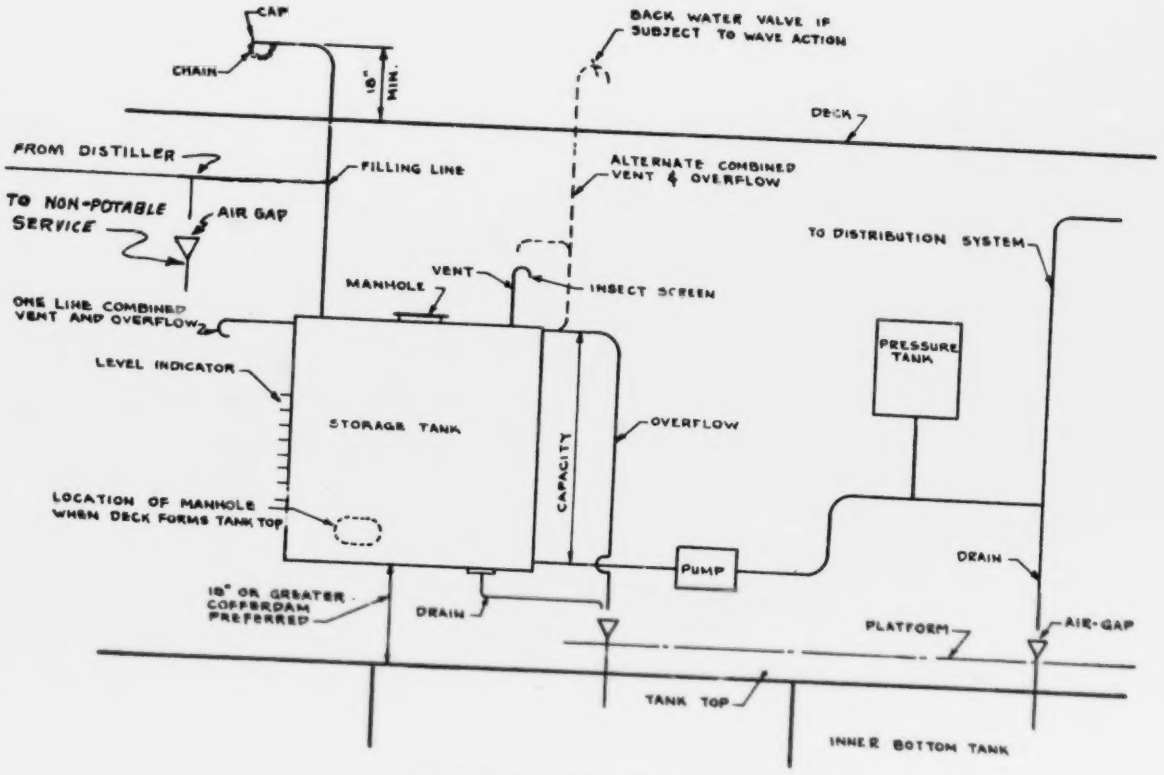
No direct connection from the potable-water system should be made for the purpose of cooling machinery or operating an aspirator, ejector, or other hydraulically operated device. A hot-water heating, air-cooling, or air-conditioning circulating-water system should not be supplied directly from a potable-water system, unless it is a closed system with no nonpotable water connections, and unless the water is not used for heat-exchange purposes in a unit containing toxic materials.

Potable water should not be used for cooling boiler water for testing purposes, unless it is supplied to or discharged from the cooler through an airgap.



TANK DRAINS

Figure 3



TYPICAL INDEPENDENT WATER SYSTEM

Figure 4

Potable-water outlets should be provided in or near passenger, officer, and crew quarters, and in the engine and boiler rooms. Drinking water fountains (see section G, item 7) should be installed, if practicable.

Coolers which permit direct contact of ice with the water, or which consist of a cooling chamber into which a water-filled bottle is inserted in an inverted position, should not be used for dispensing drinking water.

Hot and cold potable water should be supplied under pressure to the galley, pantry, and scullery. Steam which is to be applied directly to food should be made from potable water. Boiler steam is satisfactory as a means of heating potable water and food if applied indirectly, as through coils, tubes, or separate chambers.

Hot and cold potable water should be supplied under pressure to the hospital and other medical-care spaces for handwashing and medical-care purposes (but not necessarily for hydrotherapy, toilet and bedpan flushing, or bathing).

Only potable water should be used for making ice that will come in contact with food or drink.

13. PUMPS. The potable-water pump should have adequate capacity for service demands, and should be used for no purpose other than for pumping potable water. The installation of a standby pump is recommended for emergencies, such as a breakdown in the main unit serving the potable-water system.

Handpumps, which are to be installed on some vessels to serve galleys and pantries for emergency or routine use as a supplement to pressure outlets, should be so constructed and installed as to prevent the entrance of contamination into the potable-water storage tank or into the water being pumped. No pump-heads with slotted tops, nor pitcher-type pumps, should be installed.

14. PNEUMATIC (PRESSURE) TANKS. Compressed air which is to be introduced into a pneumatic tank should be supplied by:

a. A "snifter" (air-intake) airvalve on the potable-water pump, or

b. An independent compressor, or

c. A main compressed-air system using a press-on valve with a liquid trap installed in the supply line (the liquid trap being installed in the line leading directly to the pressure tank, and not less than 2 inches in diameter and 8 inches in length), or

d. Any other device which will prevent contamination of the potable water.

Where a common compressed air system supplies pressure to both nonpotable and potable water pneumatic tanks, the air supply to tanks

should be via a press-on type of air valve and hose. A press-on type air valve is one which must be held in place manually and which cannot remain connected without such manual holding.

15. IDENTIFICATION AND MARKING. The piping of the potable-water system, including the filling line, should be suitably stenciled, painted light blue, or striped with 6-inch light blue bands, or a light blue stripe, at fittings, on each side of partitions, decks, and bulkheads, and at intervals not to exceed 15 feet in all spaces except quarters, dining rooms, salons, and similar public places where the decor would be marred by such markings.

When potable water is produced aboard the vessel by treatment, the identifying markings of the piping system should begin at a point beyond the last treatment unit. When superchlorination and dechlorination are involved in the treatment process, the markings should begin immediately following chlorination. When chlorination alone is used, the piping beyond the retention tank should be marked.

The bodies of valves installed in that part of the potable-water system which is marked should be appropriately labeled.

All nonpotable water outlets should be labeled UNFIT FOR DRINKING. In some cases, faucets for both potable and nonpotable water may be so located as to be indistinguishable from each other. To avoid confusion in such cases the potable-water outlet should be labeled POTABLE.

16. DISINFECTION. Before being put into service, the potable-water storage tank and distribution system should be cleaned, disinfected, and flushed. Where a water distiller is connected to the potable-water tank or system, the pipe and appurtenances between the distiller and the potable-water tank or system should be disinfected by the same treatment as that given the potable-water system.

17. PROCEDURE FOR DISSINFECTION. Chlorine compounds which are used for disinfecting water systems are chlorinated lime, high-test hypochlorite, or commercially prepared liquid sodium hypochlorite. Chlorinated lime and liquid sodium hypochlorite can be purchased at almost any grocery or drug store. As these compounds deteriorate on exposure to air, they should be purchased in small containers, which should be tightly closed when not in use. All such products should be kept in a cool, dark place. The following instructions should be utilized in the disinfection of potable-water systems by the use of chlorine compounds:

a. Thoroughly scrub the inside surfaces of the storage tanks, and flush the tanks and distribution system with potable water.

b. Determine the volume of water necessary to fill the tanks and distribution system completely. The amount of disinfecting agent required may be determined from table II.

TABLE II.—*Amount of chlorine compound required for a 50-p.p.m.[1] solution*

Capacity of system (including tanks)		Amount of chlorine compound			
		Chlorinated lime (25 percent)	High-test calcium hypochlorite (70 percent)	Liquid Na hypochlorite	
Gallons	Tons			5-percent solution	10-percent solution
		Pounds	*Pounds*	*Gallons*	*Gallons*
1,000	4.2	1.6	0.6	1	0.5
2,000	8.3	3.2	1.2	2	1.0
5,000	20.9	8.0	3.0	5	2.5
10,000	41.7	16.0	6.0	10	5.0

[1] Parts per million.

NOTE: A heaping tablespoon holds approximately ½ ounce; a measuring cup, approximately 6 ounces.

When chlorine compounds or solutions other than those noted in the table are used, the dosage should be:

$$\text{Pounds of powder} = \frac{70}{\text{percent chlorine in compound}} \times \text{amount in 70-percent column.}$$

$$\text{Gallons of liquid} = \frac{5}{\text{percent chlorine in liquid}} \times \text{amount in 5-percent column}$$

c. Prepare the chlorine solution as follows:

(1) *Chlorinated lime.* Place the proper amount of chlorine compound in a clean, dry bucket. Add a small amount of water, and mix to a thick paste. Dilute the paste by adding water gradually and stirring constantly until a gallon or two of solution is obtained. Warm water is better than cold for this purpose. Allow the solution to stand for 30 minutes so that the undissolved particles may settle to the bottom. Pour off the clear liquid (which is the chlorine solution) and, if necessary, filter it through muslin or cheesecloth.

(2) *High-test hypochlorite.* Place the proper amount in a bucket, fill with water to within a few inches of the top, and stir until the powder is dissolved. Disregard slight turbidity, if any.

(3) *Liquid sodium hypochlorite.* These solutions require no preparation.

d. Pour the chlorine solution into the potable-water tanks.

e. Immedaitely after introducing the chlorine solution, the tanks should be completely filled with potable water Sufficient mixing usually will be obtained by the swirling action of the incoming water.

f. Open the taps and outlets on the distribution system nearest the storage tanks, and allow the water to flow until chlorinated water is detected. After the nearest taps have been opened, the process should be continued outward from the tanks until all taps and outlets have been flushed with chlorinated water. Care should be taken to insure

that the pressure tank is filled with chlorinated water. Since a certain amount of the chlorinated water will have been drawn from the storage tanks, they should be refilled to overflowing, and chlorine solution should be added, if necessary, to obtain the 50-p.p.m. dose in the tanks.

g. After the storage tanks and the piping system have been filled, the chlorinated water should be allowed to stand in them for at least 4 hours before discharging the water. In an emergency, the contact time may be shortened to 1 hour by increasing the dosage to 100 p.p.m.

h. After this contact period, the tanks and distribution system should be drained and then flushed with potable water until the chlorine taste is not objectionable.

i. Fill the storage tanks with potable water.

18. PURIFICATION OF WATER. Water which is to be purified on board for use as potable water may be stored in tanks formed by the shell of the vessel, provided that such tanks are free from apparent leakage, have no nonpotable piping passing through them, unless a water-tight, self-draining tunnel is provided for such piping, and are adequately protected against both the backflow and the discharge thereto of bilge or highly contaminated water.

Treatment facilities, where provided, should be suitable for the water to be purified, and should be designed to insure efficient operation and the production of a potable water which conforms to the *Public Health Service Drinking Water Standards*. Overboard water which is to be treated on vessels should be taken from areas relatively free from contamination and pollution. Bypasses should not be installed around treatment units, except where necessary as part of the treatment process. A sufficient supply of vital and fragile parts of the treatment apparatus should be available.

River water should be distilled before use as potable water.

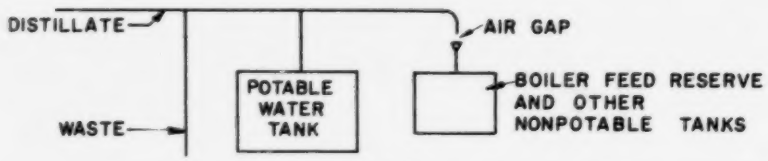
Water drawn from areas in the Great Lakes, which are relatively free from contamination, if properly disinfected will be acceptable as potable water.

The water-storage capacity in connection with a purification system should be as recommended in section A, item 5.

When overboard water is treated on board, the discharge of sewage (in relation to the water intake) should be as specified in section G, item 8.

a. *Distillation.* A distilling plant which supplies water to the potable-water system should be of such design that it will produce potable water consistently.

Provision should be made in the evaporator to prevent flooding and to minimize foaming or carryover of water into the distiller condenser. The steam coil or tubes in the evaporating chamber, and the cooling coils in the distiller condenser and the condensate cooler, should be arranged to facilitate inspection for corrosion, pitting, or leaks.



AIR GAP PROTECTION OF DIRECT DISTILLATE DELIVERY

Figure 5

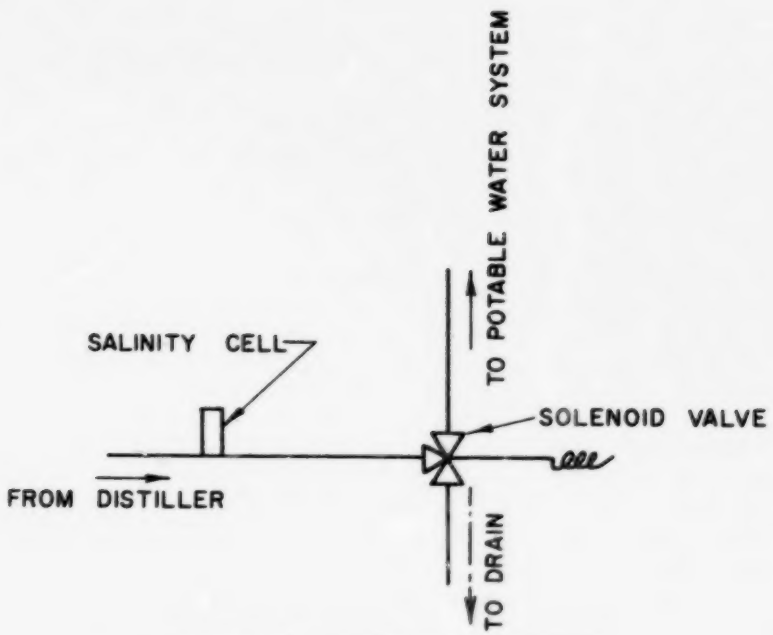
For a plant which will produce water for both nonpotable and potable water systems, the distillate should be supplied to the potable water tank and distribution system via a permanent connection. Distillate supplied to nonpotable systems should be via an air gap (see fig. 5). A swing connection (reversible ell) between the distillate discharge piping or distillate tanks and the potable water system is not acceptable.

A copy of the manufacturer's operating instructions should be posted near the distillation plant.

(1) *High-pressure units.* Atmospheric-pressure distilling plants, and those operating above atmospheric pressure, which supply potable water should be provided with a means to waste the distillate when it is unfit for use.

(2) *Low-pressure units.* Low-pressure or partial-vacuum distillation plants, which operate with pressures lower than atmospheric in the boiling chambers, should be so designed that they will consistently produce water containing not more than one-fourth grain (4.3 p.p.m.) of salinity per gallon, from sea water. A plant of this type should be equipped with a low-range, electrical salinity indicator for determining the salinity of the distillate at a point beyond the final condensate cooler. A flow-diversion valve should be provided to divert the flow of water from the potable-water system when the salinity of the distillate exceeds one-fourth grain per gallon (see fig. 6). This valve should operate instantaneously, and should be controlled by a salinity cell. The electrical control for this valve should be so arranged that the valve will operate regardless of the position of the selector switch on the salinity-indicator panel, and the flow of water should be diverted from the potable-water system when the current is off. In addition, an alarm should be provided to warn the operator when the salinity of the condensate exceeds one-fourth grain per gallon.

When evidence is lacking of the dependability of a low-pressure plant to produce water of one-fourth grain salinity under operating conditions, or when fresh- or brackish-water feed is used, one of the following measures should be taken:



SALINITY CELL—SOLENOID VALVE ARRANGEMENT

Figure 6

(a) Maintain a temperature of 165° F. or higher for 7 seconds or more in the boiling chamber, or

(b) Provide for heating the distillate to 165° F. or higher for 7 seconds or more, or

(c) Provide facilities for adequate disinfection of the distillate.

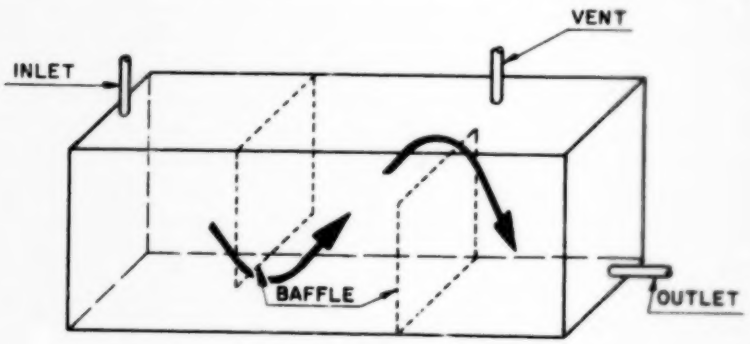
b. *Chlorination.* When water is to be regularly disinfected with chlorine, the chlorine should be applied in the form of a hypochlorite solution, using a commercial hypochlorinator which has been designed to produce the required chlorine residuals. It is desirable to apply the chlorine in direct proportion to the instantaneous flow-rate of the water being treated. Therefore, an automatic, proportional-control hypochlorinator should be used. It should be constructed or equipped so that the flow of the hypochlorite solution may be observed. Its capacity should be determined on the basis of the maximum rate of flow of water and the treatment required to produce a satisfactory chlorine residual (not less than 0.2 p.p.m. of free chlorine after 20 minutes detention or 2.0 p.p.m. of chloramine after 3 hours detention). A sampling cock should be provided at an appropriate place in the system for taking test samples to check the chlorine residual and the

operating efficiency of the feeder. A commercial testing kit for determining the chlorine residual should be obtained with the hypochlorinator. Waste drainage from the chlorinator should discharge to the drainage system through an air gap.

When water is treated regularly by chlorination, provision should be made for a baffled holding tank of sufficient capacity to provide a suitable contact period for the chlorine and water (see fig. 7). This period of contact should be provided before any water is delivered to the next successive treatment unit or to the distribution system, and should be computed on the basis of maximum rate of flow through the contact tank.

When a normal dosage of chlorine is applied, the contact period should be at least 20 minutes, with a resultant free chlorine residual of 0.2 p.p.m. When superchlorination is practiced a contact time of 5 minutes with 3 p.p.m. of free chlorine residual is required.

Superchlorinated water must be dechlorinated to remove excess chlorine and render the water palatable. Dechlorination may be accomplished either by introducing the proper amount of reducing agents such as sodium thiosulfate, sodium sulfite, or sodium bisulfite, or by passing the water through granular activated carbon. The latter method is usually practiced on shipboard by water contact with a bed of carbon in a pressure-filter type unit. All such dechlorinators should be equipped with a steam connection at the bottom, because neglected units may become incubators of after-growth bacteria. All carbon particles should be heated to at least 165° F. daily for satisfactory control. Dechlorination may be accomplished terminally by an element type filter (if acceptably constructed) without steam connections. Dechlorinating units should be designed on the basis of 1 gallon per minute per square foot of surface area for each 10 inches of depth. While rates in excess of this may be handled in new filters,



BAFFLED HOLDING TANK

Figure 7

the ability of carbon to remove chlorine decreases with the passage of time.

If dechlorination is effective before the water enters the distribution system, it is still desirable to maintain a chlorine residual in the distribution system. This may be accomplished by bypassing a small amount of the super-chlorinated water around the dechlorinating units.

c. Ultraviolet. Ultraviolet light is an acceptable disinfectant for water within certain limitations.

Ultraviolet is not acceptable as the sole treatment of river water, or water with a high organic content. Turbidity and certain colors also have an interfering effect.

No bypass around the ultraviolet disinfection unit will be permitted.

The ultraviolet unit should produce light with a peak intensity of 2,537 Angstrom units. Bulbs should be jacketed in quartz or vycor so that a temperature near 105° F. is maintained at the bulb wall. Provision must be made for frequent cleaning of the external surface of the bulb jackets. The unit must be designed to provide an energy dose of at least 11,000 microwatt-seconds per square centimeter at all points throughout the water chamber.

The following controls are the minimum necessary to achieve proper operation of an ultraviolet disinfecting unit:

(1) An automatic flow control valve on the line to or from the unit to restrict the flow through the unit under all operating conditions to no more than its rated capacity.

(2) An accurately calibrated and properly filtered intensity meter to continuously measure the ultraviolet irradiation reaching the farthest point in the unit from the bulb or bulbs.

(3) A voltmeter to indicate line voltage at the unit.

(4) An electrical circuitry coupling the ultraviolet intensity meter to a flow diversion valve and pump shutoff switch. When the ultraviolet intensity drops below that necessary to achieve the minimum 11,000 microwatt-seconds per square centimeter for disinfection, the circuitry should cause the unit to automatically divert flow from the potable water system feed line through an air-gap.

(5) A 2-minute flow delay should be designed into the circuitry to allow complete warm up of the bulbs before water is delivered to the potable water system when the disinfecting unit is first actuated or following any automatic interruption.

(6) An audible alarm to warn of any malfunction causing shutdown of the unit.

(7) Provision should be made for draining the unit when it is shutdown.

(8) Since there is no disinfecting residual from ultraviolet, provision should be made for the addition of chlorine to the water distribution system on a routine basis.

(9) Maximum water depth from the bulb surface through the water should not exceed 3 inches.

d. *Filtration.* Filtration should be used only when it is a necessary part of a purification system which includes a bactericidal treatment. Filtration of potable water, through charcoal, activated carbon, or other types of filter, is considered unnecessary except for dechlorination purposes. Faucet and other types of terminal filters often collect and accelerate the growth of bacteria, and the storage and manual insertion of replaceable filter elements may be a means of introducing contamination. Because of these potential health hazards, the use of terminal filters is discouraged unless some means is provided for disinfecting the filtering media after insertion and periodically thereafter. If replaceable filter cartridges are utilized, provision must be made for cleaning and disinfecting that portion of the distribution system subjected to manual contamination.

Water that is loaded from approved sources through clean, separate hoses and into properly constructed and maintained storage tanks should not require filtration. If filtration is necessary, it should be accomplished with approved types of pressure filters after adequate pretreatment. Where the pressure type filter is used, the filtering media should consist of at least 24 inches of suitably sized hard filter sand, or other suitable filtering material, supported either on a porous stone filter bottom or on a 12-inch bed of gravel. There should be a free board space above the sand of not less than 24 inches.

The optimum rate of flow through sand or quartz should not exceed 2 gallons per minute per square foot of filter bed area. A method for automatically controlling the rate of flow should be provided, such as a pump, the maximum discharge of which is not greater than the rated capacity of the filter.

Backwashing with water of a quality at least equal to that of the filtrate should be accomplished at a rate of at least 15 gallons per minute per square foot of filter bed area for a period of at least 10 minutes. The filter should be equipped with a loss-of-head gauge, to indicate the need for backwashing the filter media.

The valve nest or multiple port valve controlling the operation of the filter should be designed so that the filter cannot be bypassed unless the water is prechlorinated and filtration is not, in fact, a necessary part of the purification process.

Section B. WASH-WATER SYSTEM

1. GENERAL. A single water system, supplying potable water for drinking, cooking, dishwashing, ablutionary, hospital, and laundering purposes, should be installed when practicable. However, when a wash-water system is installed in additon to a potable-water system, wash water may be piped to slop sinks, lavatories, laundry facilities, bathtubs, showers, water closets, hose connectons used for deck washing purposes, and other special uses, as indicated in item 3, below. All wash water faucets should be clearly and permanently labeled, UNFIT FOR DRINKING.

Great Lakes water is taken from areas unaffected by shore or vessel contamination, is generally satisfactory to use as wash water without prior treatment. When water for washing purposes is to be taken from rivers, equipment should be installed to provide filtration and disinfection prior to use. When wash water is to be taken from acceptable shore sources, storage tanks may be filled through the potable water filling system provided an air gap is installed in the filling line to the wash water system.

2. STORAGE TANKS. Wash-water-storage tanks should be so constructed as to minimize the possibility of tne water therein becoming contaminated. Double-bottom, fore an aft peak, wing, and topside tanks and tanks with sides common to other nonpotable-water tanks, are satisfactory, provided that no drainlines pass through them (unless provided with acceptable, self-draining tunnel), that they have covered manholes, and that all sounding tubes are capped or plugged. When a deck forms the top of a wash-water tank, all openings should be curbed and covered. The tanks should be adequately protected against the backflow or discharge thereto of bilge or contaminated water.

3. DISTRIBUTION SYSTEM. The distribution lines, including the suction lines of a wash-water pump, should not be connected directly to the fire, bilge or any other contaminated water system.

The suction line to a wash-water pump should be so located as to prevent its submergence in bilge water.

Wash-water lines should be protected against backflow, in a manner similar to that required for potable water as specified in section G, item 6.

Wash water may be piped into the hospital or other medical-treatment space for use in hydrotherapy, and for any other purposes except handwashing, medical care, and drinking.

Wash water should not be piped into the galley, pantry, or scullery, except to a food waste-grinder eductor line where the delivery line is protected against backflow.

4. PURIFICATION OF WASH WATER. If river water is to be filtered before use for washing purposes the filtration should be accomplished with properly designed pressure filters. The filtering media should consist of at least 24 inches of hard properly graded filter sand, or other suitable filtering material, supported either on a porous stone filter bottom or on a 12 inch bed of gravel. There should be a freeboard space above the sand of not less than 24 inches.

The optimum rate of flow through the media should not exceed 2 gallons per minute per square foot of filter bed area. Some method for automatically controlling the rate of flow should be provided. Control may be achieved with a pump, the maximum discharge of which is not greater than the rated capacity of the filter.

Backwashing with water of a quality at least equal to that of the filtrate should be accomplished at a rate of at least 15 gallons per minute per square foot of filter bed area for a period of at least 10 minutes. The filter should be equipped with a loss-of-head gauge, to indicate the need for backwashing the filter media.

The valve nest or multiple port valve controlling the operation of the filter should be designed so that the filter cannot be bypassed unless the water is chlorinated and filtration is not, in fact, a necessary part of the purification process.

Section C. SANITARY- OR OVERBOARD-WATER SYSTEM

1. GENERAL. The sanitary- or overboard-water system should be independent of the potable-water and the wash-water systems. All faucets on the sanitary- or overboard-water-distribution system should be clearly labeled with signs reading UNFIT FOR DRINKING.

Sanitary- or overboard-water outlets should not be located in any space where food is stored, prepared or served, except that nonpotable water may be used in a food waste-grinder eductor line as noted in section E, item 10.

Water from the sanitary water system may be piped to a food waste-grinder provided the food waste-grinder is *not* located in a food space. There should be no outlets from the sanitary-water system in the hospital or other medical-treatment spaces, except those for slopsinks and flushing waste-disposal units, such as toilets and bedpan washers.

2. SALT-WATER BATHS. Salt-water service to bathtubs and showers should be independent, with no cross connections to either the potable-water or wash-water system. The supply line should originate at a point in the salt-water system where adequate flushing of the system will occur between the time the vessel leaves polluted water and the time water will be drawn for bathing purposes. Adequate flushing can best be assured by having the supply line originate at or near the pump. A shutoff valve should be installed so that this service can be made inoperative while the vessel is in polluted water. This shutoff valve should be installed just beyond the point of takeoff from the vessel's main salt-water system, and should be labeled KEEP CLOSED WHILE IN CONTAMINATED WATERS. The principle is the same as shown for swimming pools in figure 16.

Section D. VESSEL-TO-SHORE PRESSURE-WATER CONNECTION

1. GENERAL. When facilities installed on a vessel make it possible to connect any nonpotable-water system on the vessel to a potable-water system on a pier for the purpose of utilizing the pressure from the pier system, a standard device, such as double check valves or a reduced pressure principle backflow preventer, should be installed on the vessel, at or near the inlet of the nonpotable system, to prevent flow of water from the vessel to the shore.

Section E. SPACES FOR THE STORAGE, PREPARATION, AND SERVICE OF FOOD

1. DECKS. The decks or flooring of all spaces in which food or drink is stored or prepared, or in which food preparation and eating utensils are washed, should be so constructed as to be easily cleaned. The bottoms of shaft wells in these spaces should be so constructed as to facilitate cleaning and inspection. Decks should be sloped to deck drains, where provided.

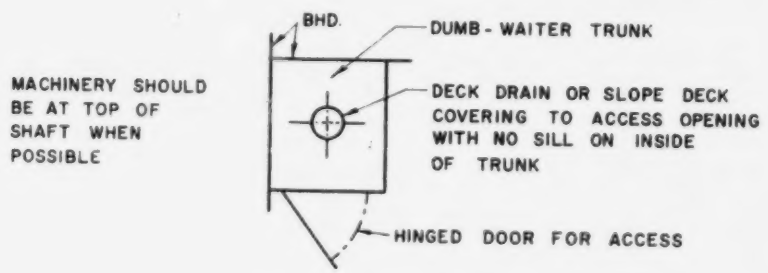
Access for cleaning should be provided in the bottom of dumb-waiter shafts. If no drain is provided in the dumb-waiter shaft, the deck covering in the shaft should be sloped to the opening for drainage to the accessible area.

2. BULKHEADS, DECKHEADS AND OTHER OVERHEAD INSTALLATIONS. Bulkheads and deckheads of spaces in which food is stored, prepared or served, or in which utensils are cleaned or stored, should have hard-finished, smooth, light-colored, washable surfaces.

Fibrous insulation or like material should be sheathed in such a manner as to prevent particles of the insulation from falling upon food. The use of cloth or plaster surfacing alone is not satisfactory.

Fibrous air filters should not be installed in the deckhead or over food-processing equipment.

Perforated, acoustical material should not be installed in galleys, pantries, sculleries, or other food-preparation or storage spaces. It will be acceptable in dining spaces, provided that the sound-absording material is of such a nature, or is so sheathed, as to prevent particles


BHD.
DUMB - WAITER TRUNK
MACHINERY SHOULD BE AT TOP OF SHAFT WHEN POSSIBLE
DECK DRAIN OR SLOPE DECK COVERING TO ACCESS OPENING WITH NO SILL ON INSIDE OF TRUNK
HINGED DOOR FOR ACCESS

PLAN OF DUMB-WAITER TRUNK

Figure 8

from falling through the holes and seams. When perforated sheets are used in the deckhead under a fibrous type of sound-absorbing or insulating material, a close-mesh, noncombustible fabric should be interposed between the fibrous material and the perforated sheet to prevent particles of the fibrous material from filtering through. The noncombustible fabric may be attached either to the insulant-absorbent or to the upper face of the perforated sheet. Other arrangements may be accepted upon application.

3. PIPING IN DECKHEADS. Pipes in unsheathed deckheads over spaces where food is stored or prepared, or where utensils are washed, or over portions of spaces from which food is regularly dispensed, should be insulated if condensation is likely to form on them.

The passage of drainage lines in the deckheads of food spaces should be avoided where possible. Where unavoidable, they should be constructed as specified in section G, item 8.

4. DRAINAGE OF SPACES. Deck drains should be provided in all spaces where decks are subjected to flooding type cleaning or where normal operations release or discharge water or other liquid wastes on the deck. Drainage gutters may be used, provided that they are so located as to be easily accessible for cleaning. If cover plates are installed over the gutterway, they should be easily removable, and should be made of heavy, flat, expanded metal or perforated plate. Deck drains should be located in the low points in a space. Drain location design should consider shear and camber and permanent trim and list. Deck drain covers should have no opening greater than one-half inch (see fig. 17).

Drains from refrigerated spaces should be protected against backflow, as indicated in section G, item 11.

5. INSECT SCREENS. An effective means should be provided for the exclusion of insects from spaces in which food is stored, prepared, or served. Screening, which is commonly used for this purpose, should be not less than 16-mesh, preferably of corrosion resistant material. Door screens should be self-closing. Skylights which are located above food spaces, and which can be opened, should be equipped with insect screens which are easily removable for cleaning. All screens should be tight-fitting.

Forced-draft-ventilation openings into food spaces do not require insect screening if insects are otherwise excluded. Tight-fitting, self-closing louvers should be installed in the outlets of forced-draft-exhaust openings.

6. TOILET AND LAVATORY FACILITIES. Adequate toilet facilities should be located convenient to food preparation spaces. Toilet rooms should be adequately ventilated. Toilet room doors opening directly into food preparation or serving areas shoud be self-closing and tight fitting. Handwashing facilities should be provided in or adjacent to

the toilet facilities and include hot and cold running water, potable or wash water, single service paper or cloth towel dispenser, or electric hot-air drying machines, a suitable soap, detergent, or other acceptable cleansing agent, and a permanent sign in the toilet space cautioning employees to wash hands.

Handwashing facilities should also be provided in the food preparation areas listed below for use by the personnel working in these areas to keep their hands clean during their activities. These facilities should include the above appurtenances except only hot and cold potable water should be used, and a permanent sign reading, WASH HANDS OFTEN, should be located over the lavatory. This wording should be used, also, where a common lavatory serves both the toilet facility and the food preparation space. Handwashing facilities should be provided as follows:

a. Central commissary (several lavatories may be needed when distance, partitions, or other obstacles might impede convenient use of the facilities).

b. Individual galleys, pantries, sculleries, bakery shops, butcher shops, and vegetable preparation rooms.

Slop sinks and scullery sinks are not satisfactory as handwashing facilities.

7. WATER SUPPLY. Only potable water should be piped into spaces where food is stored, prepared, or served, except for food waste-grinder eductor lines as noted in section E, item 10. The potable water system should be protected against backflow, as recommended in section G, item 6.

8. LIGHTING. All working surfaces in spaces where food or drink is prepared, or where utensils are cleaned, should be provided with illumination of not less than 20 foot-candles. This standard of lighting does not apply to the dining areas. Storage rooms should be lighted sufficiently to promote cleanliness and to facilitate sanitary operations (10 foot-candles minimum).

9. VENTILATION. All spaces in which food is prepared or stored and utensils washed, and all toilet spaces should be ventilated sufficiently to be reasonably free of disagreeable odors and condensation. Natural ventilation should be supplemented by mechanical ventilating systems, as needed. Louvers, filters, or registers at ventilation terminals in food preparation areas should be readily removable, without tools, for cleaning. Wing nuts or snap-on devices are recommended for this purpose.

Ventilation hoods in food spaces shall be designed to prevent grease or condensate from dripping into food or onto food preparation surfaces. Racks for the stowage of cooking vessels should not be placed under the ventilation hoods.

10. DISPOSAL OF REFUSE. Means should be provided for the sanitary storage and disposal of refuse. If garbage cans are used, a designated space, or area should be provided for washing garbage cans and should include steam or hot water under pressure, a hose equipped with adjustable spray nozzle, and a scrub brush.

If potable water or wash water is utilized acceptable backflow preventers, mounted at least 4 inches above the flood level of any can that may be washed in the space should be provided. The hose nozzle should not be adjustable to a completely closed position.

Only potable water should be introduced into the hopper, or the grinder body of food waste-grinders or disposal units located in sculleries or any other food service area. Overboard water or wash water eductors may be utilized in the horizontal discharge line from such grinders or disposal units. Overboard or wash water supplies may be used in food waste-grinders which are installed in areas other than food spaces. Acceptable vacuum breakers or air gaps should be installed in the supply lines to food waste-grinders or eductors that are flushed with potable water or eductors utilizing wash-water. All ground food waste shall be discharged to the sewage treatment unit.

11. EQUIPMENT. Utensils and equipment should be so designed, fabricated, and installed as to be free of sanitary defects which present a health hazard (refer to section F).

12. WASHING AND BACTERICIDAL-TREATMENT FACILITIES. There are several acceptable methods of washing and bactericidal-treatment of eating and drinking utensils. The following discussion of these methods will provide sufficient information for the design and construction of acceptable facilities.

A three compartment sink shall be provided whenever washing and sanitization of equipment or utensils are conducted manually. Sinks used for manual washing and sanitizing operations shall be of adequate length, width, and depth to permit the complete immersion of the equipment and utensils, and each compartment of such sink shall be supplied with hot and cold running water. Dish baskets shall be provided and shall be of such design as to permit complete immersion of the utensils and equipment components being sanitized. After utensils have been washed, and rinsed they should be subjected to bactericidal treatment by one of the following methods:

(1) By immersion of the utensil or equipment for at least one-half minute in clean water at a temperature of at least 170° F. To overcome the loss of heat from water in the bactericidal treatment compartment a heating device should be installed which will be integral with the compartment and which, preferably should be thermostatically controlled. This device should be capable of: (*a*) Within 5 minutes raising the temperature of the water in the compartment to 170° F. or higher; (*b*) maintaining the water temperature in the

compartment at 170° F. or higher during dishwashing operation. This may be accomplished with one of the following devices:

(a) A steam or electrically heated jacket under or around the compartment.

(b) Steam coils within the compartment provided that the unit is removable or rotative to a vertical position for routine cleaning.

(c) A removable, immersion-type, electrical unit in the compartment.

(d) One or more steam injectors at the bottom of the compartment, installed in such a matter as to effect thorough mixing of steam and the water. Boiler steam is satisfactory for use in this connection. Steam injectors shall be self-draining.

(e) A steam or electric recirculation unit attached directly to the bactericidal treatment compartment.

When hot water is used as the bactericidal agent, the treatment compartment should be provided with a thermometer which is accurate to within 2° F., and on which the scale divisions are not more than 2° F. The thermometer should be of the dial type, with the dial attached to the splash plate of the sink or to the adjoining bulkhead. If necessary for cleaning purposes, the thermal-immersion unit should be removable from the sink.

(2) By immersion of the utensil or equipment for at least 1 minute in lukewarm (not less than 75° F.) chlorine bath containing at least 50 parts per million of available chlorine if hypochlorites are used, or a concentration of equal batericidal strength if chloramines are used.

(3) Equipment so designed or installed as to make immersion impractical may be given bactericidal treatment: (a) With live steam from a hose, when the steam can be confined in the equipment; (b) by a boiling water rinse; or (c) by spraying or swabbing with a solution of at least 100 parts per million chlorine.

(4) Any other method determined by the Surgeon General, upon application of an owner or operator of a conveyance, to be effective in the bactericidal treatment of utensils and equipment.

Dishwashing machines, if used, should be designed, installed, operated, and maintained so that the utensils are rendered free of visible soil, wash water and detergent, leaving them clean, reasonably dry, and free of micro-organisms which present a potential health hazard. Acceptable dishwashing machines are listed in the "List of Acceptable Equipment for Interstate Carrier Use."

Scrapping facilities should be provided for removing food particles from utensils. Prerinsing facilities, if provided, will maintain the wash-water in a cleaner condition; thereby enhancing the effectiveness of the dishwashing machine.

The effectiveness of a spray-type dishwashing machine is contingent upon several factors. Some of these are inherent in their design and fabrication, while others depend upon the provision of satisfactory appurtenant equipment and proper operation and maintenance. Among the factors to be considered are the temperature and volume of the applied wash and rinse waters; the type and concentration of detergent used; the cleanliness and maintenance of the machine (which, in turn, are related to its durability and ease of cleaning); the duration of wash and rinse periods; the spray pattern; and the nozzle sizes and operating pressures. A satisfactory dishwashing machine installation requires:

(1) Provision for maintaining the wash-water in the machine in the temperature range of 140° to 160° F. Single-tank conveyor machines shall be provided with wash-water of at least 160° F.

(2) Provision of an adequate water supply for the dishwashing operation, with a dependable pressure-regulating device (flow-control or pressure-reducing valve) if required, to maintain 15 to 25 pounds of flow pressure on the final-rinse line at the machine, and not less than 10 pounds per square inch at the rinse nozzles.

(3) Provision of adequate water-heating facilities, with dependable thermostatic control, to maintain a temperature of 180° F. or more in the final fresh-water rinse line at the entrance of the rinse manifold on the machine.

(4) Provision of an easily readable thermometer for each tank and the final rinse-water line. Each thermometer should be accurate to within 2° F.

(5) Provision of sufficient racks and clean-utensil-storage area to permit air drying (usually about 45 seconds before removal of utensils from racks following washing.)

13. STOWAGE OF EQUIPMENT. Provision should be made for the stowage of all utensils in a clean, dry place above the deck, for protection against contamination. Lockers for stowage of cleaning materials and equipment should be provided in or adjacent to the food preparation space. Drawers should be removable, easily cleanable, and made of materials which are impervious and corrosion resistant. Felt lined drawers are not acceptable.

14. REFRIGERATION. Refrigerators for the storage of foods should be capable of maintaining a temperature at or below 45° F. at all times. Interior surfaces of refrigerators should be smooth, nonabsorbent, easily cleaned, and light colored.

A thermometer should be provided to indicate the temperature in the warmest zone of each refrigerator, and should be placed where it can be read with ease. The thermometer scale divisions should not

be greater than 2° F. and the thermometer should be accurate to within 2° F. Thermometers need not be installed on deep-freeze refrigerators. A thermometer is not required in a small, commercial refrigerator intended for personal use, such as that installed in the captain's pantry.

Section F. SANITARY DESIGN, CONSTRUCTION, AND INSTALLATION OF VESSEL COMMISSARY EQUIPMENT

1. GENERAL. These criteria pertain chiefly to custom-made or built-in equipment designed and fabricated by the shipbuilders or their subcontractors. Commissary equipment to be purchased on the open market, such as dishwashing machines, food mixers, ranges and other food handling, preparation, or storage equipment, should be procured only if deemed acceptable, for the purpose intended, by the Public Health Service.[3] Such acceptance is based on a careful review and evaluation of the equipment and its component parts and material, to ascertain its freedom from undesirable sanitation features; its ability to perform its sanitary function satisfactorily; and its faculty for easy cleaning.

2. DEFINITIONS. Food is any raw, cooked, or processed edible substance, beverage, or ingredient used or intended for use or for sale in whole or in part for human consumption.

Food-Contact Surfaces are those surfaces of equipment and utensils with which food normally comes in contact, and those surfaces with which food may come in contact and drain back onto surfaces normally in contact with food.

Corrosion Resistant Material is a material which maintains its original surface characteristics under prolonged influence of food, cleaning compounds and sanitizing solutions which may contact it.

Easily Cleanable is readily accessible and of such material and finish and so fabricated that residue may be completely removed by normal cleaning methods.

Sealed is free of cracks or other openings which may permit the entry or passage of moisture.

Readily Accessible pertains to areas or surfaces that are or can be exposed for cleaning without the use of tools.

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[3] A list of acceptable equipment having sanitation significance is published and distributed annually by the Equipment Review Activity, Interstate Carrier Branch, Division of Environmental Engineering and Food Protection. Items of equipment not found on this list may be requested for review and evaluation through the Public Health Service Regional Office serving the carrier concerned.

ACCESSIBLE AREA is one that can be readily exposed for inspection and proper cleaning with the use of simple tools.

READILY REMOVABLE parts or components are those that can be disassembled or removed without the use of tools.

NONABSORBENT MATERIAL is one whose surface is resistant to moisture penetration.

DURABLE material and construction is that which is able to withstand normal use and abuse.

NONTOXIC materials are those which will not introduce harmful or injurious ingredients or substances into the food.

SMOOTH. To be smooth, the metal surfaces shall have the following finishes:

(a) Corrosion resistant alloys shall have at least a No. 4 mill finish properly applied.

(b) Cast iron, cast and forged steel, and cast nickel alloy, in the food area, shall have a surface roughness not to exceed American Standard No. 125.

(c) Other metals shall be at least as smooth as commercial grade rolled sheet steel and free of loose scale.

3. MATERIALS. Food contact surface materials should be corrosion resistant, nontoxic, nonabsorbent, easily cleanable, smooth and durable. Galvanized metal for food contact surfaces is not recommended. Paint should not be applied to these surfaces. Cutting boards should be of a material equal to, or better than select hard maple.

Solder, when used as a food contact surface, should be limited to joining metal or sealing seams between abutting metal surfaces; should be of such formulation as to be nontoxic under use conditions; should contain no more lead than is necessary under good manufacturing practice; and should, consistent with good industrial practice in the refining of its constituent elements, be free of cadmium, antimony, bismuth, and other toxic materials. Welding materials used in welding together noncorrosive materials should render the weld area corrosion resistant.

Materials, other than those already accepted and listed for use as food contact surfaces or containers, should be approved by the Public Health Service before installation. Plastic, or other nonmetallic materials intended for food contact surface use, will be investigated to determine their toxicologic status.

4. DESIGN AND CONSTRUCTION. Food contact surfaces should be free of open seams, cracks, or crevices and should be easily cleanable. Exposed bolts, nuts, threads, screw heads, and rivets are not acceptable on these surfaces. All internal corners in equipment should be rounded with a minimum radius of one-fourth inch, and edges should be finished smooth.

Soldered and welded areas, used as food contact surfaces, should be smooth and durable. The deposited metal should be finished to eliminate sharp angles, cracks, or crevices.

Food areas should be protected against leakage or seepage of lubricants or other extraneous or foreign substances.

Drawers and bins used as food contact surfaces should be readily removable and easily cleanable. They should be free of open seams or cracks and finished smooth on all sides. Covers, insets, or receptacles for unpackaged foods or beverages should be readily removable or designed for easy cleaning in place.

Equipment housing or component parts should be free of openings into inaccessible areas wherein food, liquid, or dust may enter and insects harbor. Mixers, refrigerator compressors and similar units, if provided with openings or louvers, should contain readily removable inspection ports or panels. Control mechanisms, couplings, and other components mounted on the housing of the equipment should be so designed and installed as to preclude the entrance of dirt and vermin and the formation of inaccessible areas which may prevent proper cleaning and inspection.

Top openings on horizontal food storage cabinets should be protected around their periphery by a coaming three-sixteenth of an inch or more above the surface of the cabinet or above the overflow level if applicable. Openings in work or dish tables to garbage and waste receptables should have a water tight turned-down edge extending at least one-half inch below the table surface, unless the opening is provided with a scrap block.

Exposed edges and nosings on horizontal surfaces such as tops of dressers, tables, and shelves should have turned down or return flanges with a space of at least three-fourths inch between sheared edge and the frame angles, or they should be totally enclosed. Range sea rails should be readily removable and easily cleanable. Brackets for range sea rails should be easily cleanable.

Hoods over steam kettles, ranges, and other cooking units should have smooth, easily cleanable interiors. Gutters, and gutter drains, if provided, should be designed and sized to facilitate cleaning. Filters, if used, should be so installed as to direct drippings into gutters. Baffles, vanes, dampers, and other air control facilities should be readily accessible or removable.

Where exposed refrigerant coils are located in food compartments, they should be of a finless type and arranged so as to allow through cleaning. Blower or fin type evaporators should be enclosed or shielded to protect them from spillage of food and to protect the food from condensate drippage. Enclosed type refrigeration evaporators should be provided with condensate drains. Refrigerant and water coils in water cooling units should be readily accessible

for brush cleaning and provided with plug and drain to facilitate flushing and draining of the water bath compartment.

Sliding doors on galley and pantry equipment should be removable and their tracks or guides so fabricated as to be free of inaccessible openings or slots. Lower tracks should be slotted at ends to facilitate removal of dust and debris. Equipment doors, whether sliding or hinged, should not contain openings into inaccessible areas. If gaskets are used on insulated doors, they should be easily cleanable, replaceable, and should fit tightly.

Door catch openings, latch striker plates and other fastening devices should be free of openings into channels, door panels or other component parts of the equipment which could permit the entrance of vermin and debris. Latches, hinges, and other hardware should be fabricated of smooth and easily cleanable material.

Cutting boards should be readily removable for cleaning or easily cleanable in place. They should be free of open seams or cracks and should be finished smooth on all sides.

Insulation material should be protected from seepage and condensation. Flashing or closing strips should not permit entry of food fragments or debris.

Bases, curbs, or elevated islands for supporting equipment above deck level, if provided with toe space, should not be indented a distance greater than the height of the lower framing member of the equipment above the deck. Toe space should have a minimum height of 2 inches. When the area under deck mounted equipment is not entirely enclosed, legs supporting such equipment should be so constructed as to prevent collection and harborage of dirt, vermin and debris. Enclosed spaces such as columns, vertical supports, legs, etc., should be sealed against vermin entrance.

Coaming around equipment such as steam kettles, should be sealed against seepage, infiltration and vermin entrance, and should be provided with drains having removable strainers. The drain should be located at the lowest point within the area. Drains for galley and sink equipment should be sized as follows:

(a) Sinks—1½inches minimum diameter.

(b) Steam tables and Bain Maries (wet type)—1 inch minimum diameter.

Exposed horizontal drain pipes, including the trap, should be so installed as to permit proper cleaning of the deck area beneath. Such pipes should not be located above food storage, preparation or serving areas, unless designed and installed as per section G, item 8.

Water inlets to steam tables, kettles, and other sink type equipment should be located a minimum distance of twice the diameter of the water inlet but not less than 1 inch above the flood level rim. Vacuum breakers of an acceptable type and properly installed are satisfac-

tory where the water supply line is required below this height (see section G, plumbing, for details and further explanation).

Shelves used as false bottoms should be readily removable or sealed in place to preclude the entrance of food fragments and vermin to space beneath.

Silverware containers should be removable and so designed and fabricated as to permit hot water or chemical sanitization.

Dipper wells, for ice cream dippers, should be equipped with running water from an above-the-rim inlet and constructed of smooth, seamless material.

5. INSTALLATION. All permanently installed or stationary equipment should be constructed or flashed to exclude openings in way of adjacent structures or other equipment unless adequate clearance for proper cleaning is provided.

Deck or bulkhead mounted equipment which is not enclosed underneath should have a minimum clearance of 6 inches between the lowest horizontal framing member of the equipment and the deck. Counter mounted equipment should have a clearance of at least 4 inches between lowest horizontal member and the counter top.

Clearance between the back of *enclosed* equipment, such as ranges and refrigerators, and the bulkhead should be governed by the combined length of the items. Equipment up to 2 feet long should be at least 6 inches from the bulkhead; 3 feet long should be 9 inches; 4 feet long should be 12 inches; etc., up to a maximum of 24 inches. If the space between equipment and bulkhead is readily accessible from both ends, the above clearances may be reduced in half, except that the minimum in any case should be 6 inches.

If two items of equipment, such as oven or ranges, are located adjacent to each other, the space between should be at least 6 inches, if the depth is 2 feet or less. For depths greater than 2 feet, the sliding scale indicated above should be applied. In lieu of this, the space between should be effectively closed on all sides by tightly fitting spacers.

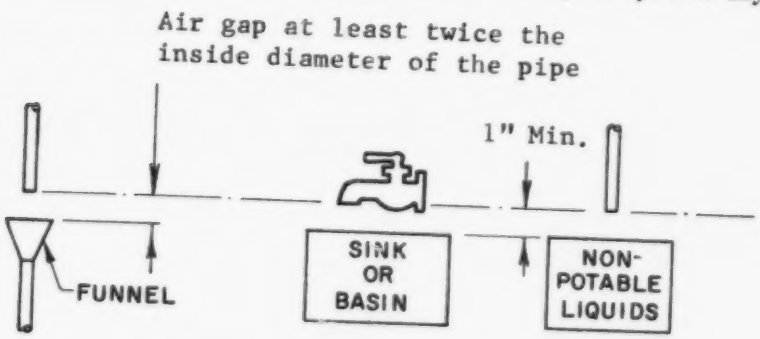
Equipment installed without the clearances stated above should have the spaces under, adjacent, and in back thereof effectively enclosed and sealed to deck and/or bulkhead. Penetrations, such as cable, conduit or pipe openings, should be provided with tightly fitting collars, or other closure fittings and materials acceptable to the Public Health Service.

Section G. PLUMBING

1. MATERIALS. Only new pipe, tubing, or fittings should be used in the potable-water system, and all materials used should be acceptable to the Public Health Service. Lead pipe and cadmium-lined fittings should not be used. Plumbing should comply with requirements of the current edition of the National Plumbing Code.

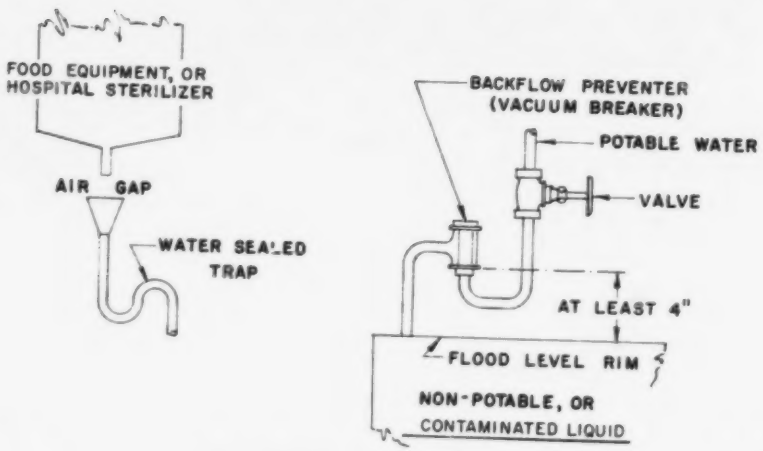
2. AIRGAPS. An airgap is the unobstructed vertical distance through the free atmosphere between the lowest opening from any supply pipe or fixture drain and the flood-level rim of the receiving receptacle. The length of an airgap should be at least twice the inside diameter of the delivery pipe or drain that it protects, with a minimum of 1 inch. When a receiving funnel is provided, the gap should be measured from the top of the funnel to the end of the pipe or drain (see fig. 9).

3. BACKFLOW PREVENTERS. When an airgap cannot be provided in the water supply line to a fixture, a suitable backflow preventer should be installed in the supply line. When a vacuum breaker is used for this purpose, it should be installed on the discharge side of the last control valve at least 4 inches above the flood level rim of the fixture as shown in figure 10, or in accordance with the critical distance as indicated in the latest edition of Public Health Service "List of Accepted Equipment for Interstate Carrier Use." The backflow preventer should be so designed that a complete cycle of any



AIR GAP FOR POTABLE-WATER SERVICE LINES

Figure 9



INDIRECT WASTE AND VACUUM BREAKER

Figure 10

moving parts is made each time the control valve and the supply line is opened and closed. Acceptable backflow preventers may be found in the "List of Accepted Equipment for Interstate Carrier Use."

4. BACKWATER VALVES. A backwater valve is a mechanical device installed in a soil or waste line to prevent the reversal of flow under conditions of back pressure. In the check-valve type, the flap should swing into a recess when the line is flowing full, to preclude obstructing the flow.

5. FIXTURES. All fixtures should be resistant to the corrosive effects of salt water and saline atmosphere. Fixtures should be easy to clean, and so designed as to function efficiently. Internal corners of a fixture should be rounded, wherever practicable.

6. PREVENTION OF BACKFLOW INTO THE POTABLE-WATER SYSTEM. The potable-water system should not be cross-connected to any nonpotable-liquid system, and no provision should be made for such a connection. Overflows, vents, and drains from tanks, and drains from the distribution system (including any water treatment plant), should not be directly connected to sewage drains. When drain lines are extended toward the bottom of the vessel, they should terminate at least 18 inches above the inner-bottom plating, or above the highest point of the bilge in the absence of such plating, unless the hydraulics of the potable-water system are such that backflow is impossible. Airgaps and receiving funnels should be installed in these lines when they discharge to a closed tank of a nonpotable-water system, or to a deck drain or to a sanitary drain.

The delivery of potable water to sinks, wash basins, bathtubs, expansion tanks, laundry trays, clothes-washing machines, boiler-water spill-tanks (hot wells), waste-disposal units, laboratory and hospital equipment, aspirators, certain equipment used in the preparation or processing of food, or equipment for the washing of eating and drinking utensils, should be through an airgap. Where an airgap is impracticable, a backflow preventer should be installed.

A direct connection of the potable-water system to the jacket of a steam kettle is satisfactory.

7. DRINKING FOUNTAINS. Bowls or basins of drinking fountains and coolers should be constructed of impervious, nonoxidizing material, and should be so designed and constructed as to be easily cleaned and protected against backflow. The jet of a drinking fountain should be slanting, and the orifice of the jet should be protected by a guard in such a manner as to prevent contamination by droppings from the mouth or by splashing from the basin. The orifice of such a jet should be at least three-fourths inch above the rim of the basin.

The water-supply pipe should be provided with a pressure-regulating valve, which will permit the regulation of the flow of water to the fountain, so that the valve manipulated by the user of the fountain will merely turn the water on or off.

The waste opening and pipe should be of sufficient size to carry off the water, and should be provided with a strainer. The drain should be trapped, if it ties into a drainage system.

8. DRAINAGE SYSTEMS. Drains should be of adequate size to prevent clogging and subsequent backflow of sewage or contaminated waste into the fixtures and spaces they serve. Provision should be made to prevent the pipes from freezing.

No drainage line of any kind, nor any pipe carrying wash water, salt water, or other nonpotable liquid, should pass through any potable-water tank, unless as specified in section A, item 6.

Soil-waste drains should not pass over potable-water-tank manholes. Toilets and bathroom spaces should not extend over any part of a deck which forms the top of a potable-water tank.

All nonpotable piping (service and drainage lines) should be so arranged that they do not pass directly over or through spaces where food is stored, prepared, or served, or spaces where utensils are washed. In instances where structural limitations may conflict with the location of drain lines in accordance with this criteria, special consideration may be given to alternate designs minimizing connections, special piping materials and installation practices in order to preclude the possibility of leakage. Examples of stronger and less corrosive drainage line materials which may be accepted in alternate construction are extra-heavy galvanized steel with welded joints; galvanized, standard, wrought iron with welded joints; cupro-nickel alloy tubing

(containing at least 10 percent nickel) with silver brazed joints; or other approved materials on file with the Public Health Service. In addition, the system should be hydrostatically tested for leakage, and no cleanouts should be provided over such spaces. Joints may be butt-welded provided that no welding bead remains within the pipe. Butt-welding may be avoided by the application of a sleeve coupling which is welded at the ends of the sleeve.

Food waste-grinders or disposal units located in sculleries or any other food service area may cause an aerosol. Therefore an eductor which may utilize overboard water should be provided in the horizontal discharge line from such grinders or disposal units. Such an installation is not required for food waste-grinders installed in separate garbage disposal areas or food waste-grinder rooms.

When fresh water from overboard is to be treated aboard a vessel for use as potable water, the sanitary overboard discharge should not be on the same side as the water intake. When it is not practical to locate the sanitary overboard discharge on the opposite side of the vessel from the water intake, it should be located as far aft and as far above the water intake as feasible.

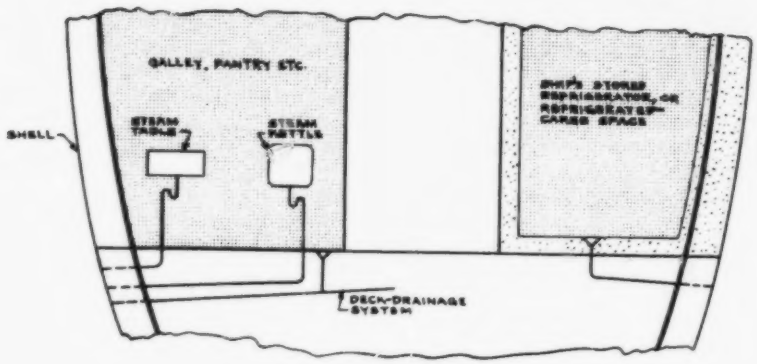
Drainlines carrying sewage, food particles, or other putrescible matter, should not be discharged to the bilge. Deck drains from kennels and other areas where animals will be housed should be connected to the sewage system.

9. VENTS AND TRAPS. Drainage systems which receive sewage, ablutionary water, or other putrescible waste, should be provided with vents and water-sealed traps as are necessary to prevent gases or obnoxious odors from entering any space served. The water-sealed traps should be so designed as to minimize the deposition of settleable solids. A trap should be of the same size as the drain to which it is connected. When there is an airgap in the drain, the trap should be installed below the airgap.

10. CLEANOUTS. Cleanout and "rodding" plugs should be installed at appropriate places in the drainage system. They should not be installed in those parts of drainage systems which are near potable-water-tank manholes or in spaces where food is stored, prepared, or served. Means of opening and cleaning traps should be provided.

11. PREVENTION OF BACKFLOW OF WASTE. Individual airgaps should be placed in the drainlines from certain types of fixtures, such as waterbath sterilizers, hospital water stills, autoclaves, steam kettles, drinking-glass rinsers, vegetable peelers, and coffee urns, as well as from all hospital and food preparation and servicing equipment which may be subject to subatmospheric pressure.

Airgaps should be placed, also, in the individual drainlines from the refrigerated-cargo spaces, the ship's-stores refrigerators, dry-



INDEPENDENT GRAVITY DRAINAGE

Figure 11

stores space, dishwashers, and equipment used in the preparation or processing of food, when such drainage is to a system which receives human sewage[4] or hospital wastes. Individual airgaps will not be required in these drainlines when one of the following conditions is satisfied:

a. The drainlines are independent of each other and of all other drainage systems (see fig. 11).

b. The drainlines discharge to open drainwells. When the drainline runs from equipment which may be subject to subatmospheric pressure, it should not be submerged in the drainwell.

c. The drainlines from such equipment and spaces are connected to a common drainage system seperate from any system carrying human wastes, and there are telltale deck-drains in each food-storage and food-preparation space; except that a deck-drain outside the space will suffice in refrigerated spaces. In the latter case, the telltale deck-drain should be in an adjacent, frequented space or passageway, and at a level at least 6 inches lower than that of the drain in the floor of the refrigerated space (see fig. 12). Nonreturn valves are preferred to telltale deck drains in drainage lines from refrigerated cargo spaces.

When a refrigerated space is located on the inner-bottom plating and its drains go to a properly vented drainwell which is emptied with a separate pump, steam-operated ejector, or bilge pump, a telltale drain may be connected to the drainwell. If a telltale drain is installed, it should be at least of the same diameter as the suction line to the pump (see fig. 13).

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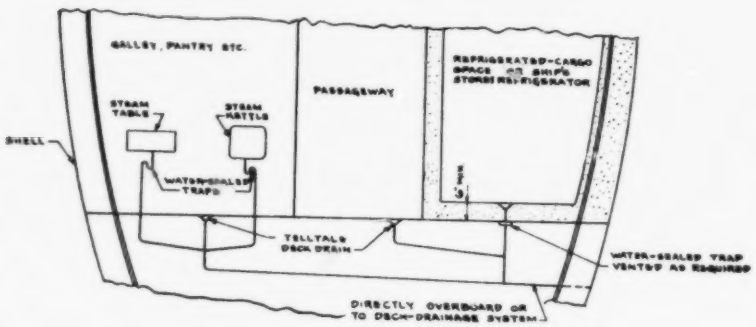
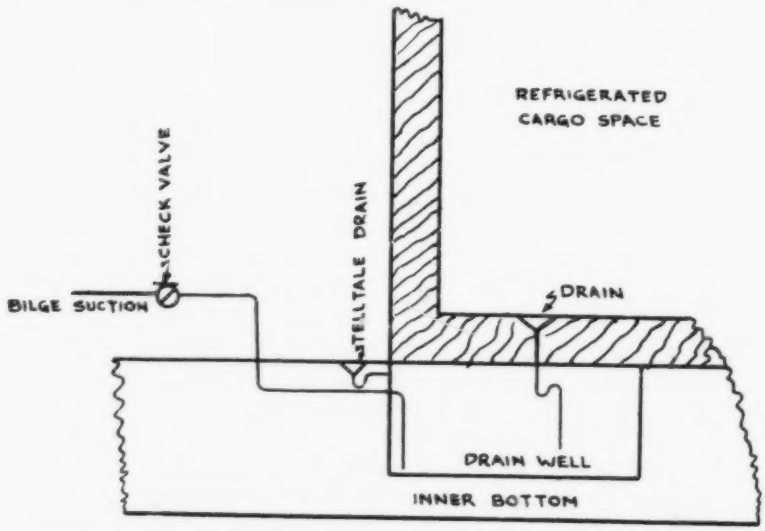
[4] Human sewage is defined as liquid wastes containing human excreta.



COMBINED GRAVITY DRAINAGE

Figure 12

Either of the drainage systems mentioned in a, b, and c, may be discharged by gravity directly overboard, or through airgaps to other drainage systems. Pumps or steam-operated ejectors are satisfactory in continuous drainage systems which discharge above or below the waterline, regardless of the elevation of the spaces drained, provided that telltale, overflow deck-drains are installed as recommended in c, above (see fig. 14). Ejectors which are operated by overboard water should not be installed in continuous systems. When wastes



DRAINAGE OF INNER BOTTOM DRAIN WELL

NOTE: Vent when necessary

Figure 13

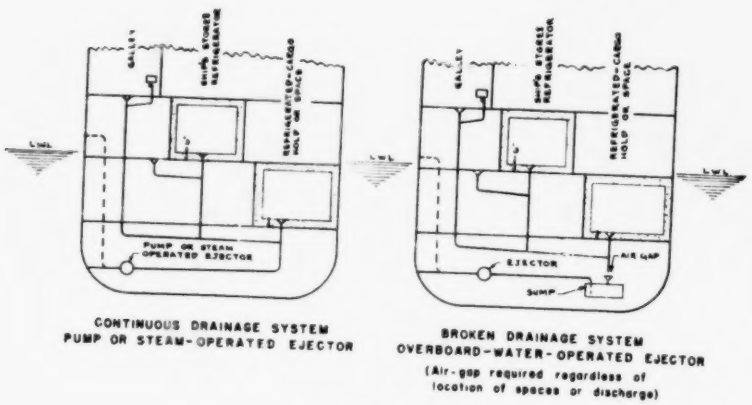


Figure 14

from these food storage and preparation spaces are discharged through an airgap to a sump, ejection from the sump by means of an overboard, water-operated ejector is satisfactory.

12. SEWAGE RETENTION AND TREATMENT SYSTEMS.* Facilities to treat wastes from toilets, urinals, facilities in hospital areas handling fecal material and wastes from food waste-grinders, when such grinders are installed, should be provided. In lieu of treatment, these wastes may be collected in holding tanks properly equipped with pumps and piping, so that the wastes can be discharged to approved shore-based or floating installations.

All galley wastes, exclusive of ground food waste, which might contain grease should pass through grease interceptors prior to their discharge overboard or to the treatment unit aboard the vessel. Where grease interceptors are installed, the grease collected should be disposed of by incineration, stored for disposal ashore or disposed of in another approved manner. Grease interceptors should be designed and installed in accordance with the applicable provisions of the National Plumbing Code, ASA A40.8.

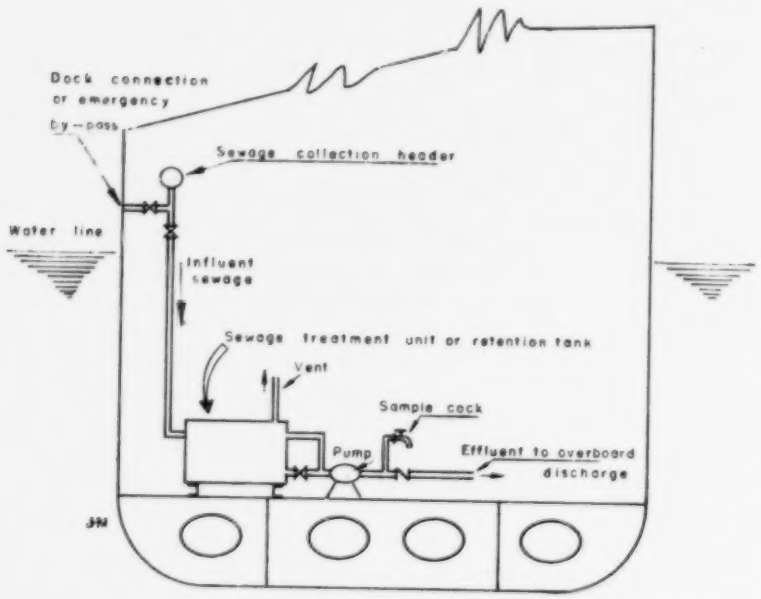
The design of treatment facilities and holding tanks should be based on an average flow of at least 30 gallons per capita per day.

For vessels with a normal complement (passengers and crew) of 41 or more, minimum treatment should be such as to produce an effluent, without the benefit of dilution with water in addition to that required for the normal operation of contributing sanitary fixtures, with 50 MG/L or less of Biochemical Oxygen Demand (B.O.D.), 150 MG/L or less of suspended solids, and 1,000 or less coliform bacteria per 100 ml. Facilities should be provided for the storage of excess sludge for proper ultimate disposal.

For vessels with a normal complement (passengers and crew) of 40 or less, minimum treatment should consist of passing the wastes through a grinder followed by disinfection which will produce an effluent having 1,000 or less coliforms per 100 ml. without benefit of dilution with water in addition to that required for the normal operation of the contributing sanitary fixtures.

A method of disinfection equally effective to chlorination may be acceptable where disinfection is required to produce an effluent meeting the coliform requirements specified.

The discharge piping from the sewage treatment unit should be provided with a valve for sampling the treated effluent.



TYPICAL SEWAGE UNIT FOR LARGE VESSEL

Figure 15

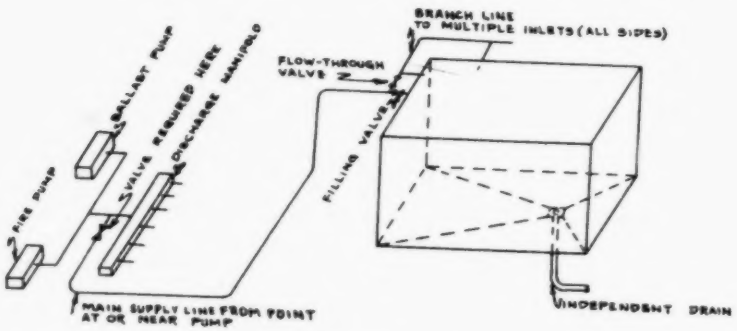
*At the time this revision was being printed, there were pending Amendments to the Interstate Quarantine Regulations and the Foreign Quarantine Regulations which will require all new vessels or vessels undergoing major conversion to be equipped with facilities to treat or retain wastes as specified in this Section. It is recommended that such facilities be provided, or that space be assigned, on new vessels for future installation.

Section H. SWIMMING POOLS

1. GENERAL. Fill-and-draw swimming pools should not be installed. Recirculating swimming pools should be constructed in accordance with the recommendations in the latest edition of *Suggested Ordinance and Regulation Covering Public Swimming Pools*, published by the American Public Health Association, 1790 Broadway, New York, N.Y. Flowing-through, salt-water swimming pools—the type most practicable for seagoing vessels and their water-supply systems—should be so designed as to provide maximum protection for swimmers.

2. SALT-WATER POOL. The number of bathers that can use a swimming pool safely at one time, and the total number that can use a pool during one day, are governed by the area of the pool and the rate of replacement of its water with clean water. Therefore, the pool should be designed with special attention to the probable peak bathing load and the maximum space available for the construction of a pool. The following principles should be applied in the design of flowing-through, salt-water pools:

The design capacity of the pool should be judged on the basis of 24 square feet per bather. For the maintenance of satisfactory clean water in the pool, the rate of flow of clean sea water should effect complete replacement at least once every 6 hours or less. The flowing-through water should be delivered to the pool through multiple inlets,



FLOW-THROUGH SWIMMING POOL

Figure 16

located so as to insure uniform distribution. These inlets should be served by a branch line taking off from the main supply line, at the pressure sides of the filling valve near the pool. This branch line should be designed to effect replacement of the water in the pool every 6 hours or less. Control of the flow should be independent of the filling valve.

The overflow should be discharged into scum gutters or a similar boundary overflow, with multiple outlets spaced not more than 15 feet apart, discharging to the overboard drain or the bilge.

A drain should be installed at the lowest point in the pool, and its inside diameter should be of sufficient size to insure quick emptying. The drains from the pool should preferably be independent; however, when connected to any other drainage system, a backwater valve should be installed in the swimming-pool drainline.

The bottom of the pool should slope toward the drain or drains in such a manner as to effect complete drainage of the water from the pool. In the interest of safety, the slope of the bottom of any part of the pool in which the water is less than 5.5 feet deep should be not more than 1 foot in each 15 feet. There should be no sudden change of slope within the area where the water depth is less than 5.5 feet.

It is preferable to have a separate water-supply system, including the pump. The water intake should be forward of all sanitary drains from the vessel. However, if the pool will be filled and the flowing through will occur only when the vessel is underway, it will be satisfactory to use the fire or sanitary-overboard-water pumps, or a combination of these pumps, provided that:

a. The delivery line to the pool is independent of other lines originating at or near the discharge of the pump or the valve manifold, or at a point where the maximum or near-maximum flushing of the fire or sanitary-overboard-water pump and main is routinely effected.

b. A readily accessible shutoff valve is located close to the point of take-off from the fire or sanitary-overboard-water system, and is permanently and conspicuously labeled KEEP CLOSED WHILE IN CONTAMINATED WATERS.

3. RECIRCULATION TYPE POOL. All swimming pools of the recirculation type shall be designed in accordance with the above referenced manual so that, with proper operation, the danger to the health of passengers and crew is minimized. Water that is introduced into the pool directly or through the recirculation system from the potable water system or into the recirculation system from the wash water system should be through an airgap.

The system should provide filtration, including necessary water conditioning, which will clarify all water in the pool every 8 hours or less. Equipment should be provided so that water can be properly disinfected and the alkalinity controlled.

Section I. ACCOMMODATIONS

1. GENERAL. Accommodations for passengers and crew should be such as to protect the health of the occupant and to prevent the introduction, transmission, and spread of communicable diseases.

Section J. HEATING, VENTILATING, AND LIGHTING

1. GENERAL. It is beyond the scope of this handbook to set forth standards for these areas. In general, however, heating, ventilating, and lighting should be adequate in living spaces to maintain a healthful and comfortable environment.

Lighting and ventilation, as aids in the maintenance of good sanitary conditions in food-preparation, food-storage, and food-service spaces, should conform to recommendations in section E, and items 8 and 9.

For standards of good practice, reference is made to the following publications:

Guide & Data Book, (Fundamentals ASHRAE and Equipment Application), American Society of Heating, Refrigerating, and Air-Conditioning Engineers, United Engineering Center, 345 East 47th Street, New York, N.Y., 10017.

IES Lighting Handbook. Illuminating Engineering Society, United Engineering Center, 345 47th Street, New York, N.Y., 10017.

Section K. RATPROOF CONSTRUCTION

1. GENERAL. Rats have followed man to almost all inhabited parts of the world carrying with them certain human diseases, destroying his possessions, and interfering with his economic and physical well-being. Rats were probably first brought into the United States in early colonial times by vessels. Several epidemics of plague in seaport cities are believed to have been transmitted through infected ship rats. In addition to plague, murine typhus fever, salmonellosis, trichinosis, hemorrhagic jaundice or Weil's disease, and rat-bite fever are known to be transmitted by rats. To guard against further introduction of disease-carrying ship rats, this section of the manual is included in order that vessels may be constructed in a ratproof manner.

Ratproof construction of a vessel consists of design and fabrication in such a manner as to eliminate or render inaccessible those spaces which may afford a rat harborage or be a source for food and water for rats. It is intended to control rat infestation and to prevent the passage of rats from one section of a vessel to another. The ratproofing requirements listed herein apply to U.S. flag vessels engaged in foreign traffic. Ratproofing of interstate carriers is required only in areas where food is stored, prepared, or served.

2. DEFINITIONS.

RATPROOF AREA.—An area which is completely isolated from other areas by means of dependable ratproofing.

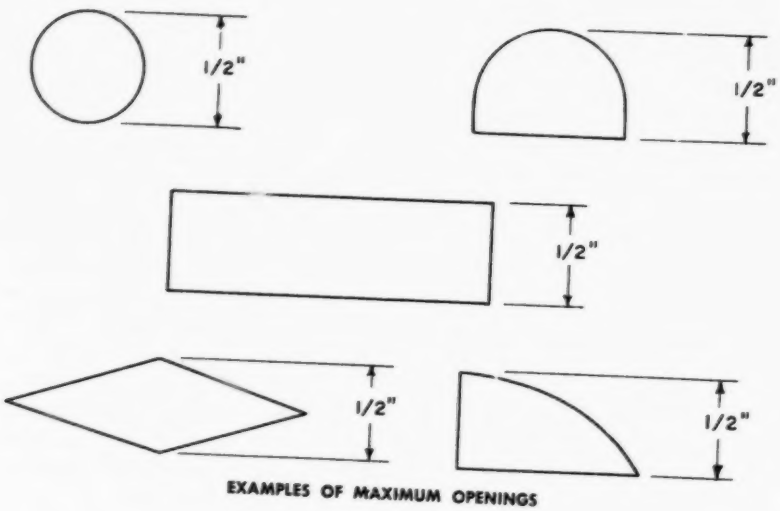
RAT-TIGHT AREA.—An area all boundaries of which are resistant to the easy passage of rats. All openings into the area should be tight-fitting, meeting the maximum opening definition. Exposed edges need not be flashed with a ratproof material.

RATPROOF MATERIAL.—A material, the surface and edges of which are resistant to the gnawing of rats.

ACCEPTABLE NONRATPROOF MATERIAL.—A material, the surface of which is resistant to the gnawing of rats when its exposed edges are flashed with a ratproof material.

MAXIMUM OPENING.—The largest opening through which a rat cannot pass. Regardless of the shape of the opening, it should be one-half inch or less in the minimum dimension, as shown in figure 17.

OPEN-TYPE CONSTRUCTION.—Construction by which partially en-



EXAMPLES OF MAXIMUM OPENINGS

Figure 17

closed places are open to view for inspection and accessible for maintenance.

CLOSED-TYPE CONSTRUCTION.—Construction by which places that are not easily inspectable are closed by means of dependable ratproofing.

EASILY INSPECTABLE.—Places which are open to view from the deck or conveniently accessible for inspection.

FLASHING.—The capping or covering of corners, boundaries, and other exposed edges of acceptable nonratproof material in ratproof areas. The flashing strip should be a ratproof material, wide enough to cover the gnawing edge or edges adequately, and be firmly fastened.

3. RATPROOF MATERIAL. Ratproof materials should be thick enough to resist tearing by rats and able to withstand any blows to which they may be subjected within the areas of use. Such materials include steel plate, sheet iron or steel, sheet aluminum or metal alloy of suitable hardness and strength, perforated sheet iron, expanded metal, flattened expanded metal, wire and hardware cloth.

Expanded metal, flattened expanded metal, perforated sheet metal, and wire mesh or hardware cloth used for ratproofing should meet the maximum opening requirements, as defined.

Minimum thicknesses of ratproof materials for various areas may be found in chart form in appendix A.

Throughout this section of the handbook, the gauges of metal or sheet metal specified refer to iron only. When aluminum is substituted for iron, it should have a thickness by the Brown & Sharpe gauge next greater than the thickness specified by U.S. Standard for sheet

iron. For example, aluminum of 16-gauge (Brown & Sharpe) is suitable to replace iron of 18-gauge (U.S. Standard).[5]

4. ACCEPTABLE NONRATPROOF MATERIALS. Certain nonratproof materials are satisfactory in ratproof areas provided that the boundaries and miscellaneous gnawing edges are flashed, as defined. Wood and inorganic composition materials are acceptable under the following conditions:

a. Wood should be dry or seasoned, and free of warps, splits, and knots. Plywood should be resin-bounded and waterproof.

b. Inorganic composition sheets and panels should be relatively strong, hard, and with surfaces which are smooth and resistant to gnawing of rats. A list of acceptable nonratproof materials may be obtained from one of the Public Health Service offices listed. If a new material is intended for use, the nearest Public Health Service office should be contacted in order to initiate approval procedures.

c. Certain composition sheets and panels which do not meet b above may be made acceptable by being metal-laminated or faced on one side with 24-gauge sheet metal. Another method is to face both sides of such composition sheets or panels with 24-gauge sheet metal or a hard surfaced composition material. All materials in this category are subject to Public Health Service approval for inclusion on the acceptable nonratproof materials list.

A chart indicating minimum thicknesses of acceptable nonratproof materials for various areas may be found in appendix B.

Cements, putties, plastic sealing compounds, lead and other soft materials or materials capable of being gnawed through and subject to breaking loose should not be used in lieu of ratproofing materials to close small openings. Firm, hard setting materials used to close openings around cables within ferrules are subject to approval by the field inspector.

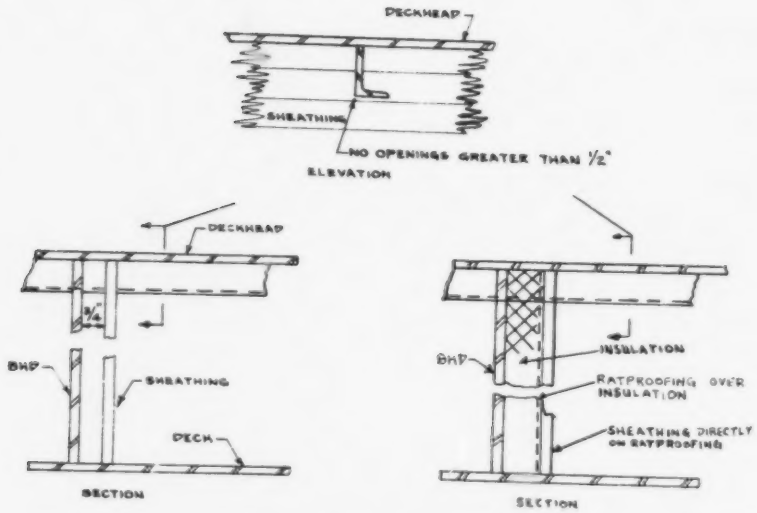
Fiberboards and plasterboards are generally not acceptable nonratproof materials.

5. RATPROOF-EXEMPT SURFACES. Nonratproof sheathing need not be ratproof when placed flush against, or not more than three-fourths inch from steel plate, or flush against ratproofing material over insulation. Overlapping joints or minimum thicknesses are not necessary for sheathing so placed (see fig. 18).

Wooden-screen bulkheads need not be ratproofed when placed flush against, or not more than three-fourths inch from, steel plate or ratproofing material, or so constructed that the screen bulkhead is on at least 4-inch vertical bearers, terminates at least 6 inches above the deck or other horizontal ledge which may be behind or intersect it,

---

[5] Gauges given herein are U.S. Standard for sheet iron and expanded metal, Brown & Sharpe for aluminum, and American Steel & Wire for wire cloth.

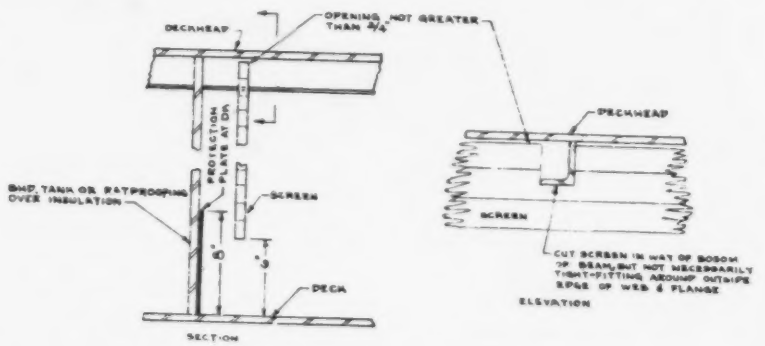


RATPROOF EXEMPT SHEATHING

Figure 18

and the top of the screen is extended to within three-fourths inch of the deck-head, but is not extended into the bosoms of the beams, girders, or brackets (see fig. 19). When so constructed, overlapping joints in the screen bulkhead are not necessary. From a ratproofing standpoint, this type of screen bulkhead is preferable to metal-sheathed or flashed types.

Single subdivisional bulkheads between two rat-tight areas need not be ratproofed.



RATPROOF EXEMPT SCREEN BULKHEAD

Figure 19

6. GENERAL RATPROOFING CRITERIA. Ratproof areas, as defined, are as follows: Galleys, pantries, other commissary spaces, enclosed bars, refrigerated ships stores spaces, cargo holds, refrigerated cargo holds, tonnage openings, storage spaces (including deck lockers, slop lockers, any electric panel lockers, or boxes, etc.), forepeaks, afterpeaks and chain lockers, also the *perimeters only* of engine, boiler, and fan rooms, auxiliary machinery spaces, CO_2 rooms with insulation, plenum chambers, and shaftways (including elevators and dumbwaiters), and other similar areas. Service installations, equipment, furniture and fixtures within the above ratproof areas should be installed in such a manner as to eliminate rat harborages. They should preferably be easily inspectable. Otherwise, they should be made ratproof.

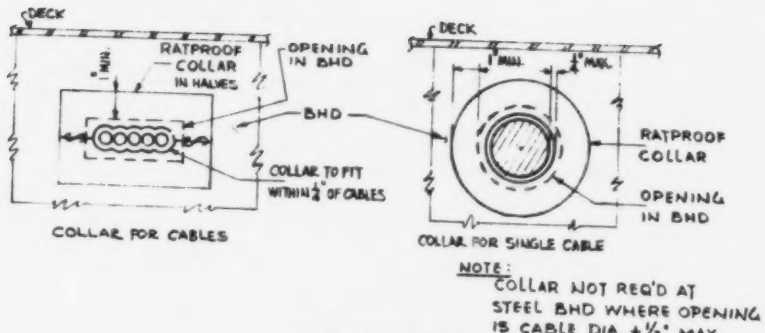
Rat-tight areas, as defined, are as follows: Quarters, dining and mess rooms, public spaces such as lounges, saloons, theaters, etc., fan room casings, gyro room, radio room, chart rooms, wheelhouse, the casing of CO_2 rooms with insulation, and other similar areas. Service installations, equipment, furniture and fixtures within the above rat-tight areas should be installed in such a manner as to eliminate rat harborages. Preferably, they should be easily inspectable or made rat-tight.

The following are acceptable methods for making an area ratproof:

a. *Penetrations of ratproof material.* All such penetrations should be kept to within one-half inch of the penetrating fixture or closed to within one-half inch with ratproof materials. Penetrations by pipes, cables, ducts and other fixtures subject to movement should be closed to within one-fourth inch on all sides so that, after moving, the maximum opening will still be no greater than one-half inch.

b. *Penetrations of acceptable nonratproof material in ratproof areas.* Gnawing edges should be flashed, as defined. The perimeter of an opening in these materials, caused by the penetration by structural members or service lines, should be ratproofed by placing a sheet metal collar to within one-fourth inch of the penetrating fixture and fastening it to the penetrated surface. Although 22-gauge sheet metal is sufficient for ratproofing purposes, heavier gauge metal is recommended for those ratproof areas which may be subject to damage. The minimum overlap of every gnawing edge by the metal collar should be 1 inch (see fig. 20). Plastic pipe should be collared snugly.

c. *Joints and perimeters of acceptable nonratproof material in ratproof areas.* Gnawing edges should be flashed, as defined. The flashing material must be on one side of the nonratproof material, either visible or concealed. The minimum overlap on each gnawing edge should be 1 inch. These criteria apply to all joints and perimeters including vertical and horizontal seams at corners, decks, and deckheads. Flashing need not be placed over tightly fitting tongue-and-groove, shiplap, or similar overlapping joints (see figs. 21 through 25).



CABLE PENETRATIONS

Figure 20

Acceptable nonratproof materials which are metal faced or laminated (see item 4c) are ratproof on gnawing edges and no further protection of joints and perimeters is necessary.

d. *Penetration in rat-tight areas.* All such penetrations which are snug need not be protected on the gnawing edges. Openings which are not snug should be collared with 22-gauge sheet metal securely fastened. In all cases, no openings greater than one-half inch will be permitted.

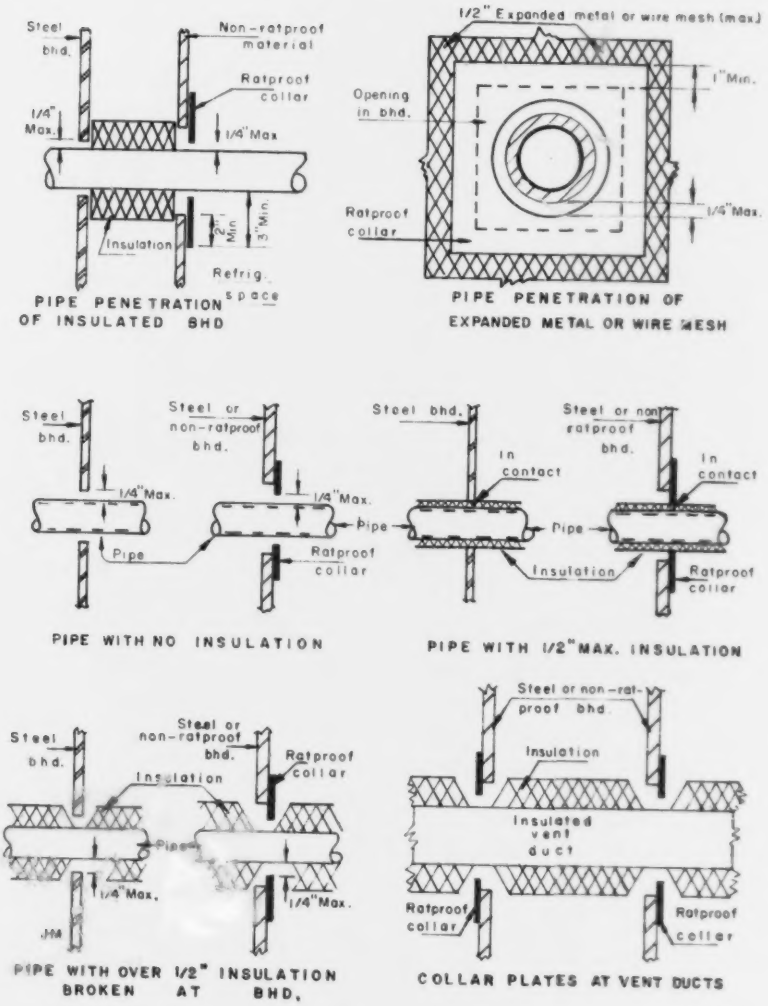
e. *Joints and perimeters in rat-tight areas.* Joints and perimeters in such areas including vertical and horizontal seams at corners, decks, and deckheads should fit tightly in conformance with good shipbuilding practice.

f. *Double bulkheads.* Double bulkheads dividing two ratproof areas must both be ratproofed if the void between is greater than three-fourths inch. If the void is less than three-fourths inch, only one of the bulkheads requires ratproofing.

Double bulkheads dividing a ratproof from a rat-tight area may be made ratproof on either side if the void between is less than three-fourths inch and must be made ratproof on the ratproof area side if the void between is greater than three-fourths inch.

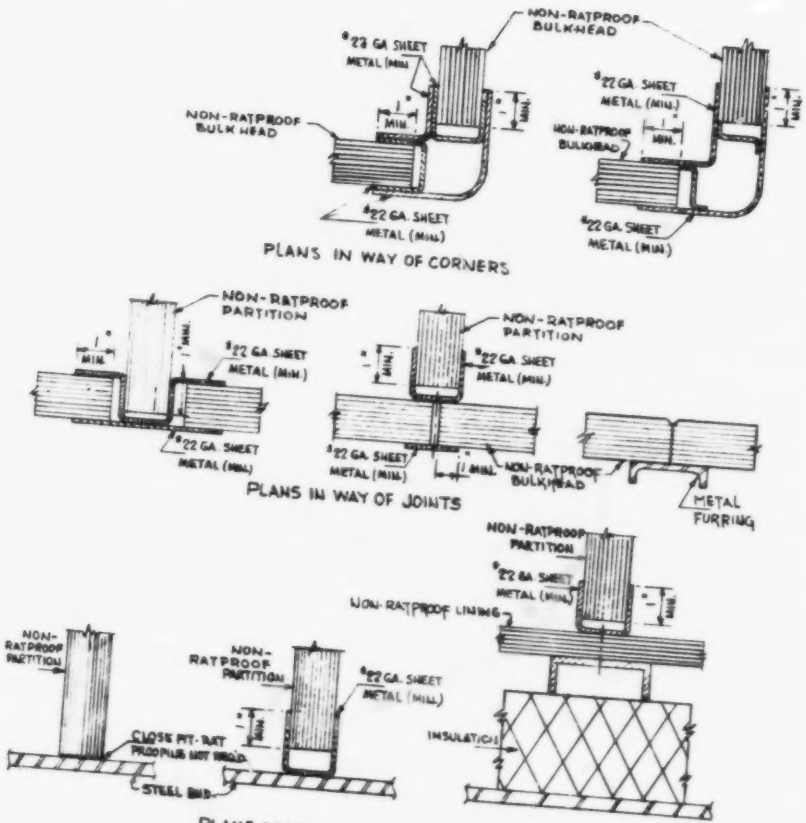
Double bulkheads dividing two rat-tight areas need not be made ratproof regardless of the void space between.

g. *Flooring: Deck coverings, portable flooring and other standing surfaces.* Permanent flooring in ratproof areas must be protected to prevent rat harborages. Whenever possible, such flooring should be so constructed as to eliminate void spaces greater than three-fourths inch between the flooring and steel deck. Allowance should be made for the welding beads of the joints, and for the difference in the elevation of plates which are lap-welded.



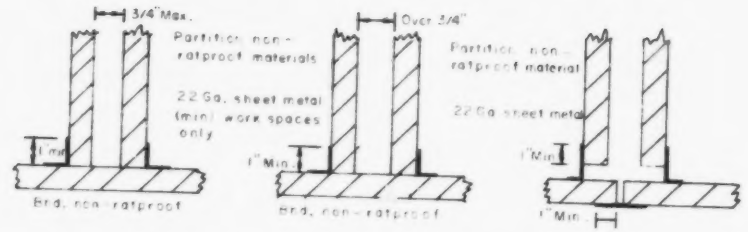
BULKHEAD PENETRATIONS

Figure 21

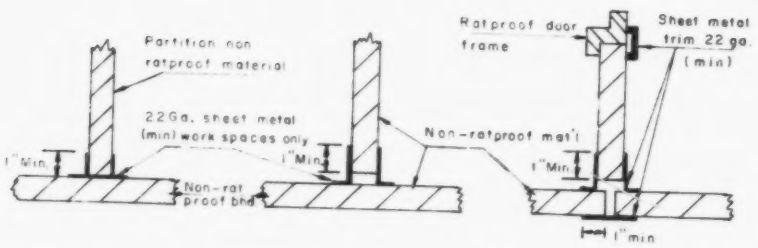


LININGS AND BULKHEADS IN RATPROOF AREAS

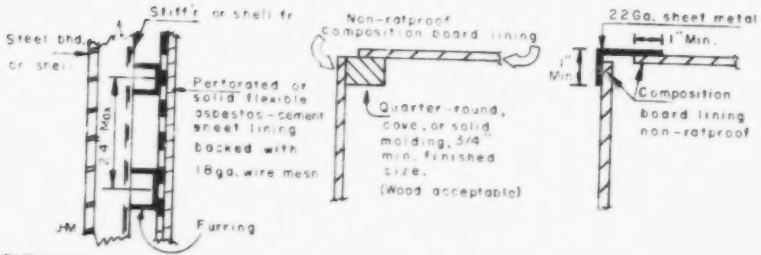
Figure 22



PLANS FOR DOUBLE PARTITIONS



PLANS FOR SINGLE PARTITIONS

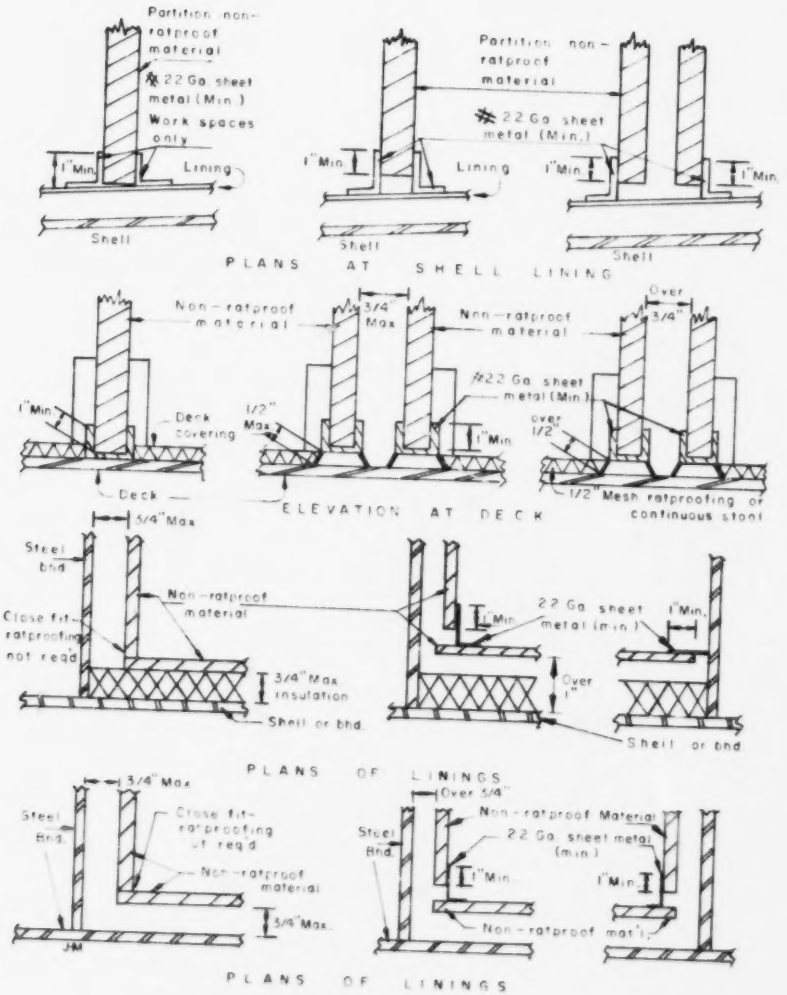

Stiff'r or shell fr
Steel bhd or shell
Perforated or solid flexible asbestos-cement sheet lining backed with 18ga. wire mesh
3/4" Max.
Furring
Non-ratproof composition board lining
Quarter-round, cove, or solid molding, 3/4" min. finished size. (Wood acceptable)
22 Ga. sheet metal
1" Min.
1" Min.
Composition board lining non-ratproof

ELEVATION OF LINING IN PUBLIC SPACES WHERE PEFORATED OR SOLID FLEXIBLE ASBESTOS-CEMENT SHEET IS USED

PLANS OF LINING AT CORNERS

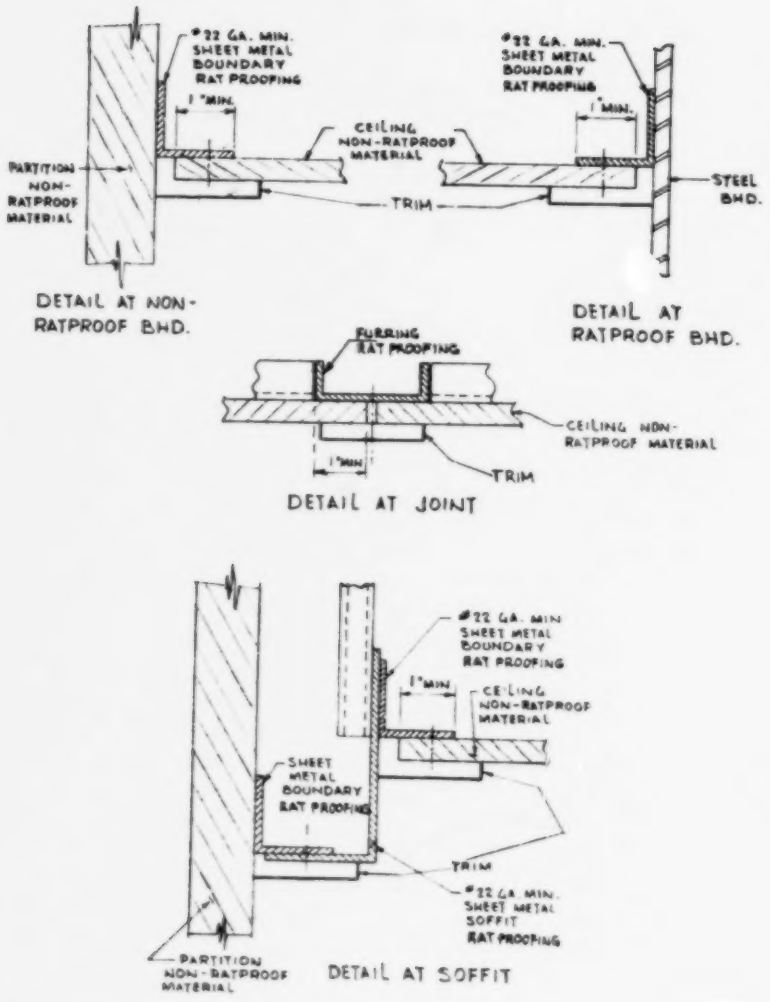
LININGS AND BULKHEADS IN RATPROOF AREAS

Figure 23



LININGS AND BULKHEADS IN RATPROOF AREAS

Figure 24



CEILINGS IN RATPROOF AREAS

Figure 25

The deck covering over insulation thicker than three-fourths inch in ratproof areas should be ratproof. To ratproof, the insulation should be completely covered with 18-gauge expanded metal, 18- to 20-gauge flattened, expanded metal, or 16-gauge steel-wire cloth in refrigerated spaces.

When mesh material is essential, it may be placed just above the insulation, or within or between layers of the covering material (see fig. 26).

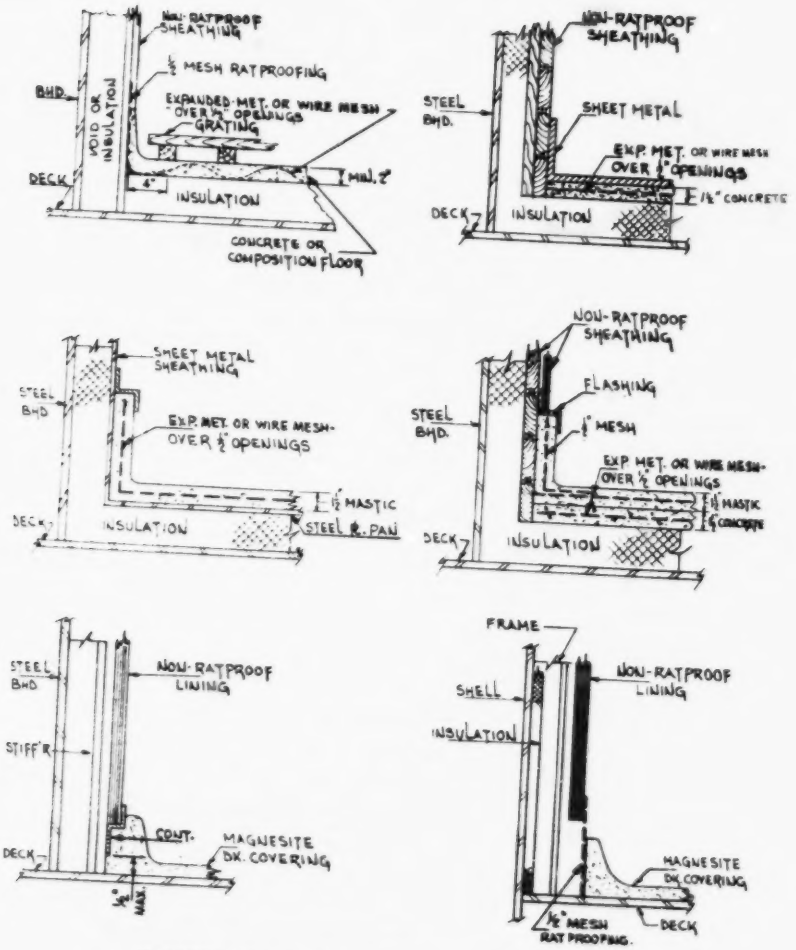
Permanent flooring with a void beneath greater than three-fourths inch must be made ratproof by flashing all gnawing edges and collaring all penetrations leaving no openings greater than one-half inch. Flooring of concrete or of hard composition material over voids containing insulation thicker than three-fourths inch, should be not less than 2 inches thick, and should be reinforced with large-mesh material. When a flooring consists of a layer of concrete and a layer of composition material, the concrete should be at least 1½ inches thick, and one of the layers should be reinforced. In all cases, the cove at the boundaries, and the curb or sheathing above the flooring and grating, should be ratproofed. When the bulkhead sheathing is an acceptable nonratproof material and there are openings greater than one-half inch between the bottom of the bulkhead sheathing and the steel deck, the cove of the flooring should be ratproofed by placing 18-gauge wire mesh (18- to 20-gauge flattened metal, or 18-gauge expanded metal will be acceptable) 4 inches into, or on the bottom of, the composition flooring and extending it up 1 inch above the bottom of the gnawing edge of the bulkhead sheathing (see fig. 6). If the bulkhead sheathing is an acceptable nonratproof material and there are no openings greater than one-half inch between the bottom of the bulkhead sheathing and the steel deck, ratproofing at the cove of the flooring is not required (see fig. 27).

Portable flooring, whether solid or open type, should be in sections of such size and weight as to be easily handled. When a hoist is not available, the portable sections should not exceed 36 square feet in area nor 120 pounds in weight. When a hoist is available, each section should be less than 75 square feet in area and should be provided with a flush ring or other means for the attachment of a hoist cable.

DETAILED RATPROOFING

7. HULL AND SUPPORTS. Horizontal stiffeners, including structural members over doors and cargo ports, should be installed toe down wherever practicable, to eliminate the partially hidden area formed behind the flange when it is placed toe up.

When deep recesses, or structural pockets created by the intersection



FLOORING AND DECK COVERING IN RATPROOF AREAS

Figure 26

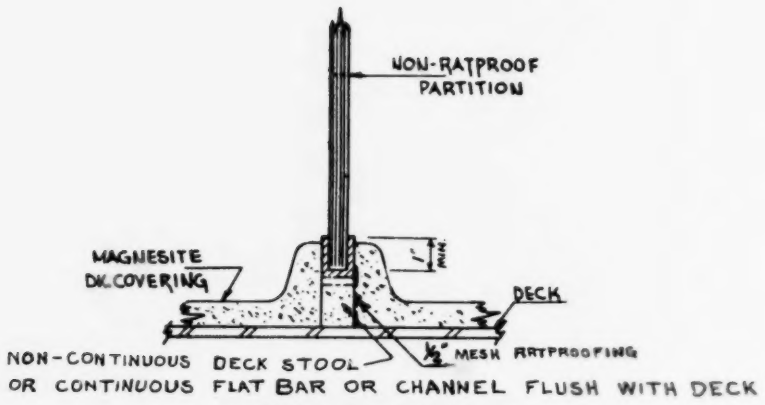


Figure 27

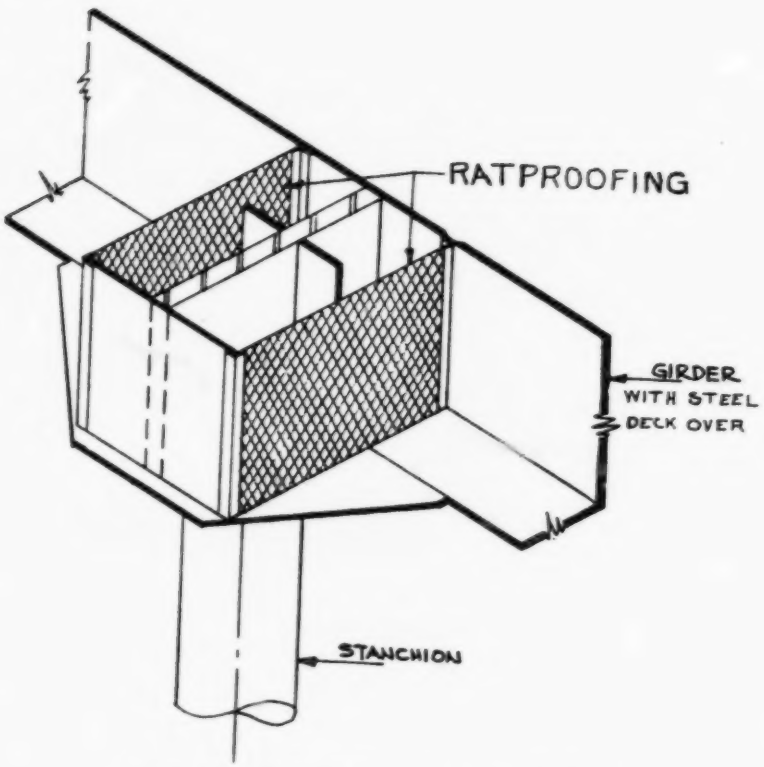
or close approach of several structural members cannot be easily inspected the space should be enclosed (see fig. 28).

8. LIGHTENING HOLES AND VOID SPACES. Lightening holes, when used as a means of opening spaces and making surfaces visible, should be employed only where they open the space sufficiently to make it easily visible, thus unattractive to rats as a nesting place. In no case should the cutting of lightening holes be recommended where the strength of structural members will be affected adversely.

Void or concealed spaces, such as cofferdams, spaces around the chain lockers or tanks and between the breasthooks, and spaces opened by lightening holes, either should be made accessible, easy to inspect, open to light, or adequately ratproofed. Such a space, when intended for the stowage of dunnage, gear, or miscellaneous material, should be enclosed and provided with hinged entrance doors or manhole covers, with means of securing them. Such doors and manhole covers should be hinged at the top and should be self-closing. If made of mesh material, the cut edges should be substantially bound with steel bars or sheet metal crimped over edges. Drain or ventilation holes or slots in solid sheet-metal skirts around void spaces should be no greater than one-half inch (See fig. 29.)

Void spaces around, under, and over tanks and other fixtures should be left open, if easily inspectable from at least two sides. This does not apply in food-storage and food-preparation areas, where all void spaces shoud be sealed (see fig. 30).

9. INTERIOR FOUNDATIONS. Other than in engine boiler and fan rooms, the bases and foundations of machinery and equipment in both ratproof and rat-tight areas should be designed and installed so as to



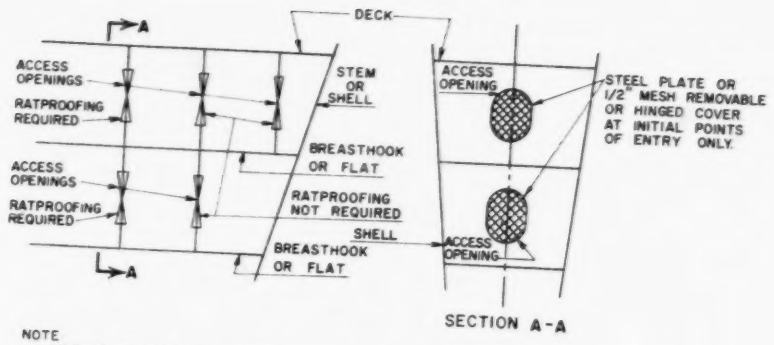
RATPROOFING AT UNINSPECTABLE STRUCTURAL POCKET

Figure 28

eliminate any partially enclosed spaces. Open-type structural steel foundations are preferred. Where lightening holes are not sufficient to permit inspection and additional lightening holes cannot be cut, the existing opening should be closed to within one-half inch with at least 22-gauge sheet metal. In commissary spaces, all foundations should be completely closed.

Openings between the top of box foundations and the base of machinery exceeding one-half inch should be ratproofed (see fig. 31).

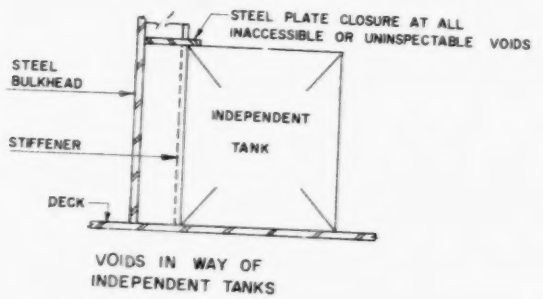
10. STEEL TANK-TOP IN LOWER HOLD. Where feasible, the steel tank-top should be extended to the ship's side, to avoid the creation of an open bilge space and the need to install a bilge ceiling. Pipes at the ship's side can be protected by battens. Coverplates over open drainwells should be perforated or slotted, with no openings greater than one-half inch. Openings into the drainwell void around the perimeter of the cover should be closed to within one-half inch. Pen-



NOTE

VOID OR CONCEALED SPACES OPENED BY LIGHTENING HOLES EITHER SHOULD BE MADE ACCESSIBLE, EASY TO INSPECT, AND OPEN TO LIGHT, OR SHOULD BE ADEQUATELY RATPROOFED.

STEEL PLATE STIFFENERS IN FOREPEAK OR AFTER PEAK

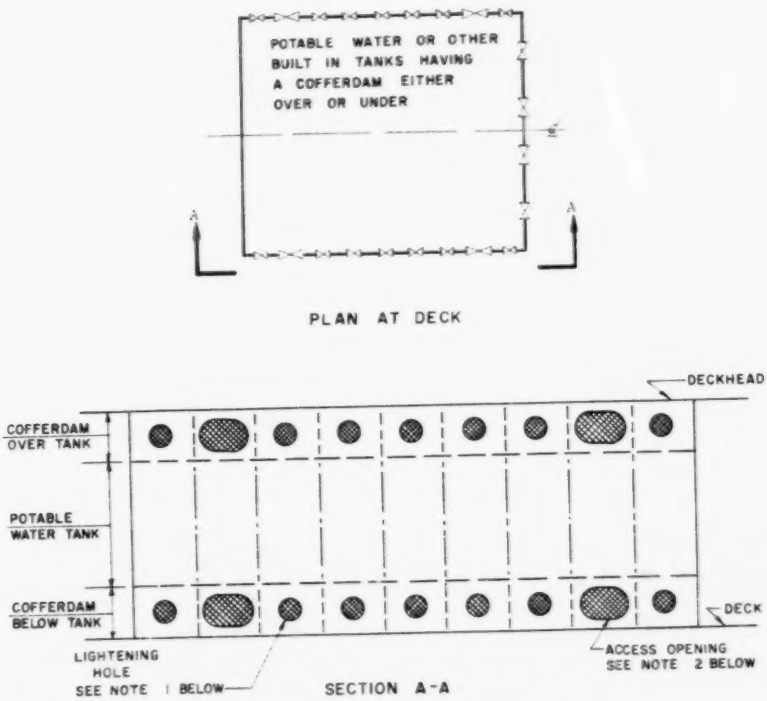


VOID SPACES

Figure 29

etrations, by pipes, through the cover should be closed to within one-fourth inch on all sides.

11. WOODEN CARGO PADS. Wooden cargo pads in general-cargo holds should be installed in direct contact with the tank-top or on three-eighths inch, flat bar bearers. In no case should the space between the cargo pad and the tank-top be greater than three-fourths inch. When thicker bearers are placed under a cargo pad, the space in excess of three-fourths inch should be filled with asphalt cement, or bituminous material, or other material which is impenetrable by rats. Cargo ramps should be constructed of steel plate; however, if wooden, they should be completely covered with 11-gauge sheet metal when the space beneath is greater than three-fourths inch. Wooden cargo pads over cork insulation in refrigerated-cargo holds should be at least 2⅝ inch thick tongue-and-groove or shiplap, and

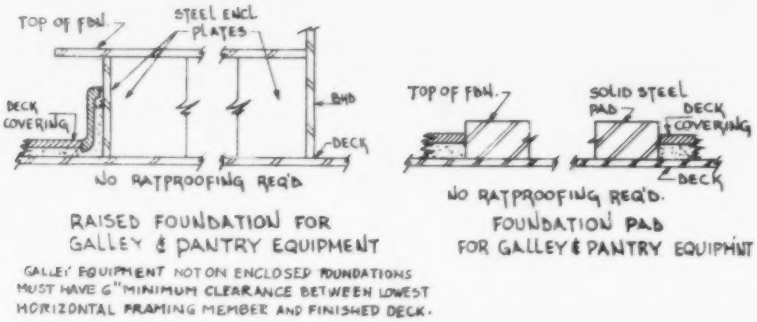

POTABLE WATER OR OTHER
BUILT IN TANKS HAVING
A COFFERDAM EITHER
OVER OR UNDER
A
A
PLAN AT DECK
DECKHEAD
COFFERDAM
OVER TANK
POTABLE
WATER TANK
COFFERDAM
BELOW TANK
DECK
LIGHTENING
HOLE
SEE NOTE 1 BELOW
ACCESS OPENING
SEE NOTE 2 BELOW
SECTION A-A
NOTE:
OPEN TYPE FOUNDATION CONSTRUCTION IS PREFERABLE BUT IF PLATE
CONSTRUCTION, AS SHOWN, IS USED THE FOLLOWING RATPROOFING MEASURES
ARE REQUIRED:
1. LIGHTENING HOLES ARE TO BE CLOSED WITH 1/2" MAX OPENINGS MESH MATERIAL
AS NOTED ON TABLES A TO E INCLUSIVE.
2. ACCESS OPENINGS TO BE FITTED WITH 1/2" MAX OPENINGS MESH PANELS
HINGED AT TOP WITH A NOTICE MARKER STATING "TO BE KEPT CLOSED
FOR RATPROOFING PURPOSES" EITHER ON THE PANEL OR IN THE
IMMEDIATE VICINITY THEREOF.

VOID SPACES

Figure 30

should be bound with steel. It is preferable that 18-gauge or heavier steel-wire cloth be placed between the ceiling and the cork, but a ceiling with tightly fitted shiplap or caulked butt joints is acceptable (see fig. 32).

12. CHAIN LOCKERS. Chain lockers should be so designed to retain any rats which might enter by way of the chain pipe. The bulkhead surrounding the locker should be of metal, and should have no holes larger than one-half inch. A bulkhead dividing the locker into two compartments need not be ratproofed. Entrance doors into a chain


TOP OF FDN.
STEEL ENCL PLATES
DECK COVERING
BHD
DECK
NO RATPROOFING REQ'D
RAISED FOUNDATION FOR GALLEY & PANTRY EQUIPMENT
GALLEY EQUIPMENT NOT ON ENCLOSED FOUNDATIONS MUST HAVE 6" MINIMUM CLEARANCE BETWEEN LOWEST HORIZONTAL FRAMING MEMBER AND FINISHED DECK.
TOP OF FDN.
SOLID STEEL PAD
DECK COVERING
DECK
NO RATPROOFING REQ'D.
FOUNDATION PAD FOR GALLEY & PANTRY EQUIPMNT
EQUIP BASE
TOP OF FDN. STOOL
CHOCK PLATE
DECK
WHERE SPACE BETWEEN DECK & TOP OF FOUNDATION IS NOT EASILY INSPECTABLE, SPACE SHOULD BE TOTALLY ENCLOSED WITH SHEET METAL & ½" MESH MATERIAL
FOUNDATION STOOL FOR DECK MACHINERY
BASE OF FAIRLEAD
SUPPORT & NO OPENINGS OVER 1"
DECK
OPENINGS LARGER THAN ½" TO BE CLOSED WITH ½" MESH MATERIAL. (UNLESS SPACE UNDER FAIRLEAD IS EASILY INSPECTABLE)
FOUNDATION FOR FAIRLEAD

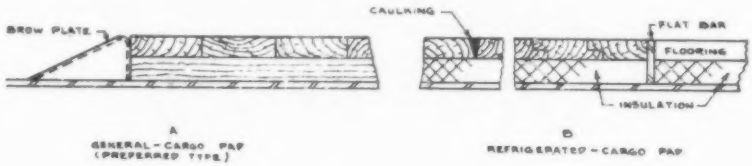
FOUNDATIONS

Figure 31

locker, and lightening holes into the space on each side of the locker, should be of ratproof construction.

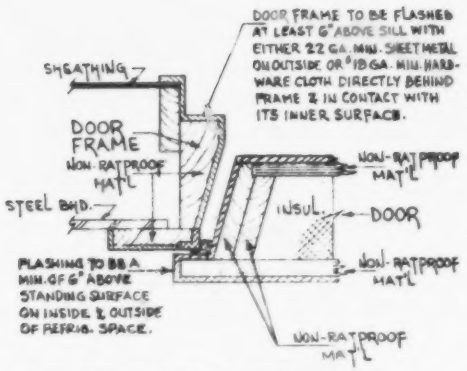
When the chain-storage space is not partitioned from the forepeak, the entire space should be considered the chain locker, and any stowage lockers located in this space should be ratproofed.

13. DOORS. Doors of acceptable nonratproof material which lead into ratproof areas should be closely fitted, and covered on the outside



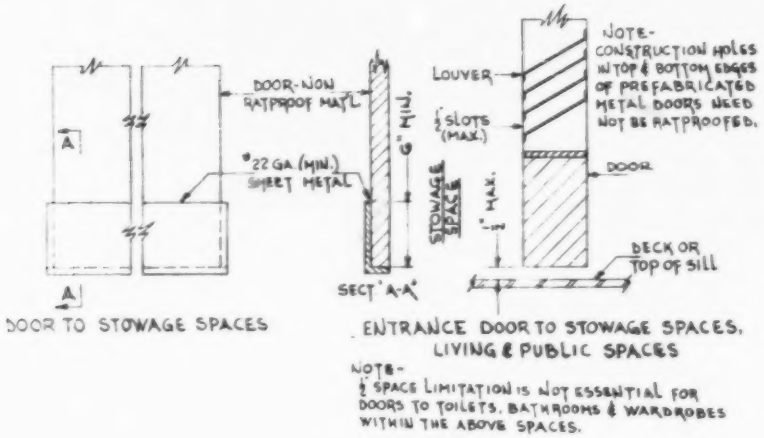
WOODEN CARGO PADS

Figure 32


DOOR FRAME TO BE FLASHED AT LEAST 6" ABOVE SILL WITH EITHER 22 GA. MIN. SHEET METAL ON OUTSIDE OR #18 GA. MIN. HARDWARE CLOTH DIRECTLY BEHIND FRAME & IN CONTACT WITH ITS INNER SURFACE.
SHEATHING
DOOR FRAME
NON-RATPROOF MAT'L
STEEL BHD.
NON-RATPROOF MAT'L
INSUL.
DOOR
FLASHING TO BE A MIN. OF 6" ABOVE STANDING SURFACE ON INSIDE & OUTSIDE OF REFRIG. SPACE.
NON-RATPROOF MAT'L
NON-RATPROOF MAT'L

FOR CARGO DOORS ONLY - NOT REQUIRED FOR SHIPS SERVICE DOORS

PARTIAL HORIZONTAL SECTION AT REFRIGERATOR DOOR


A
DOOR-NON RATPROOF MAT'L
#22 GA (MIN.) SHEET METAL
A
DOOR TO STOWAGE SPACES
6" MIN.
SECT 'A-A'
LOUVER
½" SLOTS (MAX.)
STOWAGE SPACE
1" MAX.
DOOR
DECK OR TOP OF SILL
NOTE- CONSTRUCTION HOLES IN TOP & BOTTOM EDGES OF PREFABRICATED METAL DOORS NEED NOT BE RATPROOFED.
ENTRANCE DOOR TO STOWAGE SPACES, LIVING & PUBLIC SPACES
NOTE- ½" SPACE LIMITATION IS NOT ESSENTIAL FOR DOORS TO TOILETS, BATHROOMS & WARDROBES WITHIN THE ABOVE SPACES.

RATPROOF DOORS

Figure 33

lower edge with a 6-inch wide strip of 22-gauge or heavier sheet metal. Door casings should be installed in conformance with item 6c (see fig. 33).

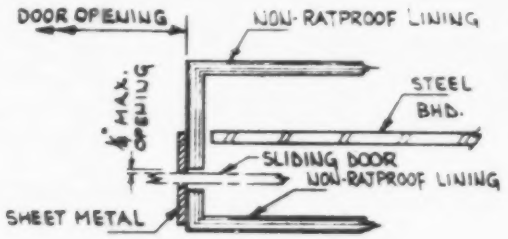
Construction holes which may be left in the top and bottom edges of prefabricated metal doors need not be ratproofed.

Slots in louvers, and the space between the sill and the bottom of entrance doors and of doors within living quarters, dining rooms, and other public spaces leading to passageways, should be one-half inch

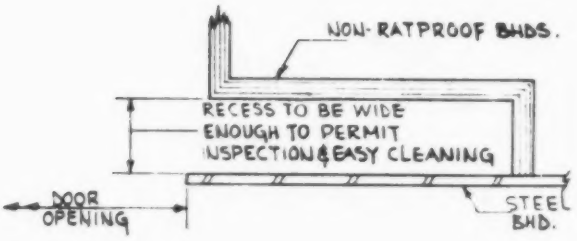
or less. This limitation is not essential for entrance doors to toilets, bathrooms, and wardrobes within these spaces.

Recesses for sliding doors should be ratproofed (see fig. 34).

14. WINDOW CASINGS. Window casings in double walls or bulkheads should be of tight construction, and preferably of metal. If not ratproof, there should be no space larger than one-half inch between the window sash or glass and the edge of the opening, whether the window is open or closed. For a window which does not slide in a tight groove, this opening should be limited to one-fourth inch on each side of the sash or glass, to avoid an opening exceeding one-half inch when the window shifts to one side. This is not necessary if the window well is ratproof. For a window sash which does not drop to within one-half inch of the well, a removable inspection panel should be provided. Windows that slide horizontally into a double well or bulkhead should pass into a pocket constructed in the same manner as the window well recommended above.



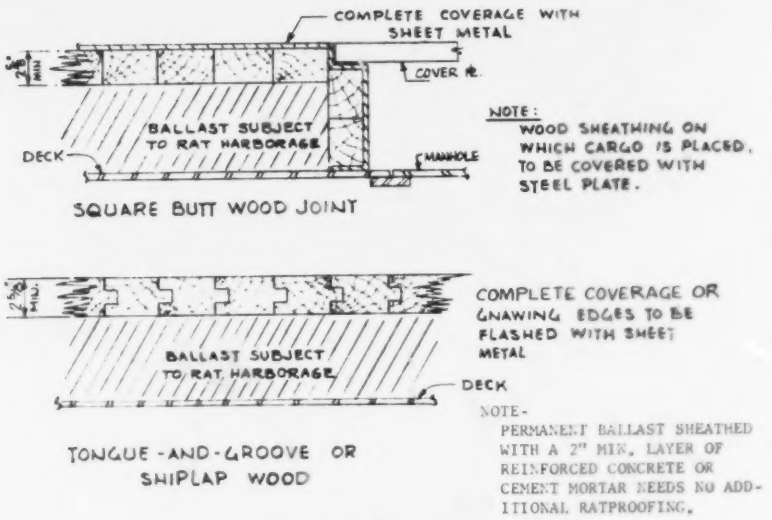
ENCLOSED TYPE



OPEN TYPE

RECESSES FOR SLIDING WATER-TIGHT DOORS

Figure 34


COMPLETE COVERAGE WITH SHEET METAL
COVER
BALLAST SUBJECT TO RAT HARBORAGE
DECK
MANHOLE
NOTE:
WOOD SHEATHING ON WHICH CARGO IS PLACED, TO BE COVERED WITH STEEL PLATE.
SQUARE BUTT WOOD JOINT
COMPLETE COVERAGE OR GNAWING EDGES TO BE FLASHED WITH SHEET METAL
BALLAST SUBJECT TO RAT HARBORAGE
DECK
NOTE-
PERMANENT BALLAST SHEATHED WITH A 2" MIN. LAYER OF REINFORCED CONCRETE OR CEMENT MORTAR NEEDS NO ADDITIONAL RATPROOFING.
TONGUE-AND-GROOVE OR SHIPLAP WOOD

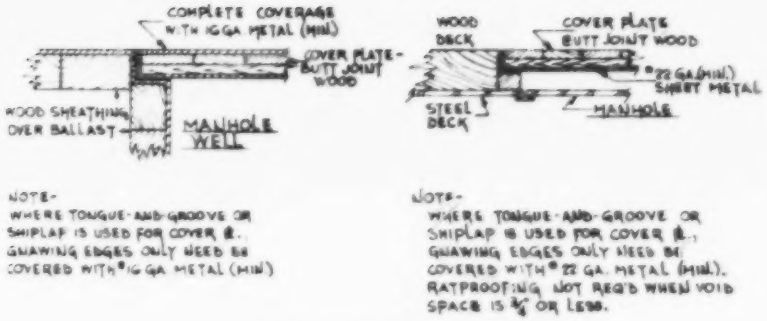
SHEATHING ABOUT PERMANENT BALLAST

Figure 35

15. BALLAST. Permanent ballast should be so installed as to avoid the creation of a rat harborage. Solid block, gravel, or sand ballast should be completely sheathed with a layer of reinforced concrete or cement mortar of adequate thickness. Wooden sheathing for permanent gravel, sand, or block ballast should be at least 2⅝ inches thick in finished size. Sheathing composed of tongue-and-groove or shiplap planking need not be covered with metal but the gnawing edges at the perimeter must be flashed, as defined (see fig. 35). Horizontal surfaces on which cargo is placed, particularly under cargo hatches, should be covered with steel plate. The lining of access manhole wells should be ratproofed in the same manner, and the edges of the covers of these wells should be completely bound with 16-gauge or heavier sheet metal. Structural steel angles should be used at vulnerable corners in cargo holds.

16. SKYLIGHTS. Skylights in food handling, preparation, storage or service areas should be screened with ½-inch mesh steel-wire cloth of a gauge suited to the span, space, and exposure, but in no case less than 18 gauge. Copper or other corrosion-resistant insect screens, though necessary in these areas, are not ratproof.

17. MANHOLES. Manhole protection covers or guards, preferably should be made of steel plate, with no opening greater than one-half inch. When made of wood, and when the void spaces created when the unit is in place are greater than three-fourths inch in any dimen-


COMPLETE COVERAGE WITH 16 GA METAL (MIN.)
COVER PLATE - BUTT JOINT WOOD
WOOD SHEATHING OVER BALLAST
MANHOLE WELL
NOTE-
WHERE TONGUE-AND-GROOVE OR SHIPLAP IS USED FOR COVER (L., GNAWING EDGES ONLY NEED BE COVERED WITH* 16 GA. METAL (MIN.)
WOOD DECK
COVER PLATE @UTT JOINT WOOD
* 22 GA (MIN.) SHEET METAL
STEEL DECK
MANHOLE
NOTE-
WHERE TONGUE-AND-GROOVE OR SHIPLAP IS USED FOR COVER (L., GNAWING EDGES ONLY NEED BE COVERED WITH* 22 GA. METAL (MIN.). RATPROOFING NOT REQ'D WHEN VOID SPACE IS 1/4" OR LESS.

COVER PLATES FOR MANHOLES

Figure 36

sion, the entire inside should be lined with 22-gauge sheet metal. Only flashing of the gnawing edges will be required if tongue-and-groove or plywood is used (see fig. 36).

SERVICE FACILITIES—PROTECTION FROM DAMAGE

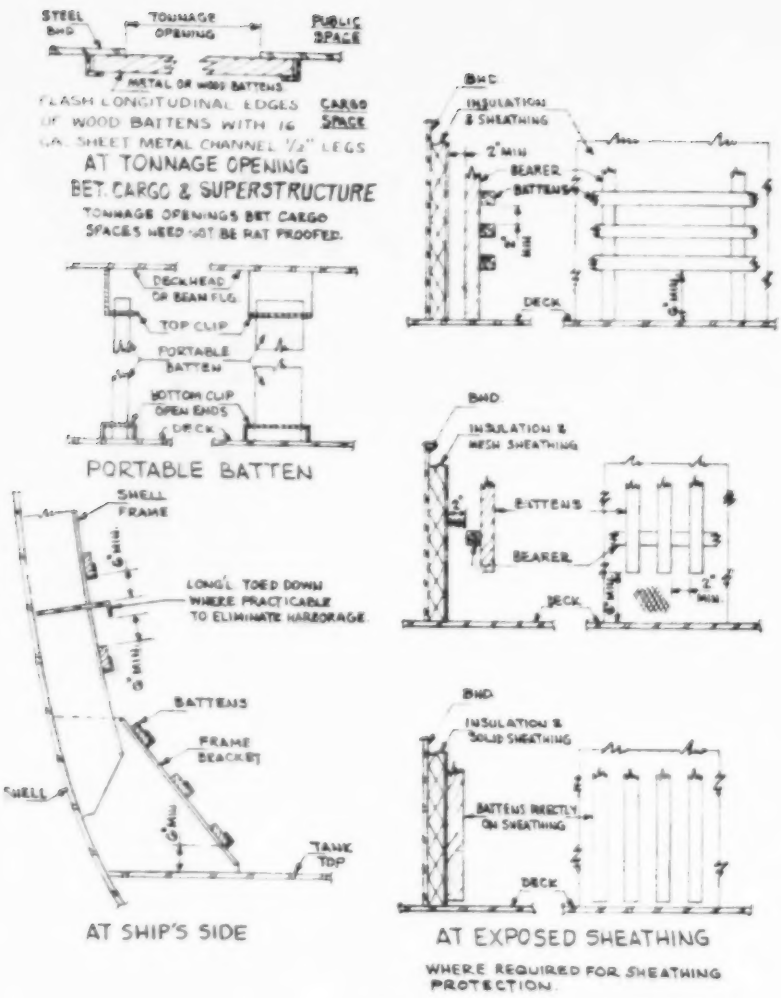
18. GENERAL. Service facilities such as pipes, cables, and ducts should, whenever practicable, be protected with open, slot-type barriers, rather than with box or enclosed types.

19. BATTENS. Steel flat bar, half-round bar, channel, or angle battens are preferred, but wooden battens are acceptable. Battens should be so installed as to form no troughs or partially hidden pockets over structural members, cables, or wireway casings. Steel or wooden battens should be at least 2 inches apart, and at least 2 inches from any adjoining pipe or bulkhead. Space between them should be sufficient to ensure visibility, but never less than the width of the batten, except in the case of vertical pipe battens.

There should be a space of at least 2 inches between the batten bearer and the surface being protected. Battens should have a minimum clearance of 6 inches from the deck, except that the cargo face, if vertical, may extend to the deck. Vertical, channel-iron pipeguards and closely adjoining angle-iron pipeguards which extend to the deck or tank top should have half-circle inspection holes at the bottom of the guard.

Horizontal battens should have a minimum clearance of 6 inches above the deck or tank-top which they parallel (see fig. 37).

20. PLATE GUARDS. Wide plate guards are generally undesirable, because they exclude light, interfere with inspection, hide rat runways, and create rat harborages. When installed, they should be carefully



BATTENS

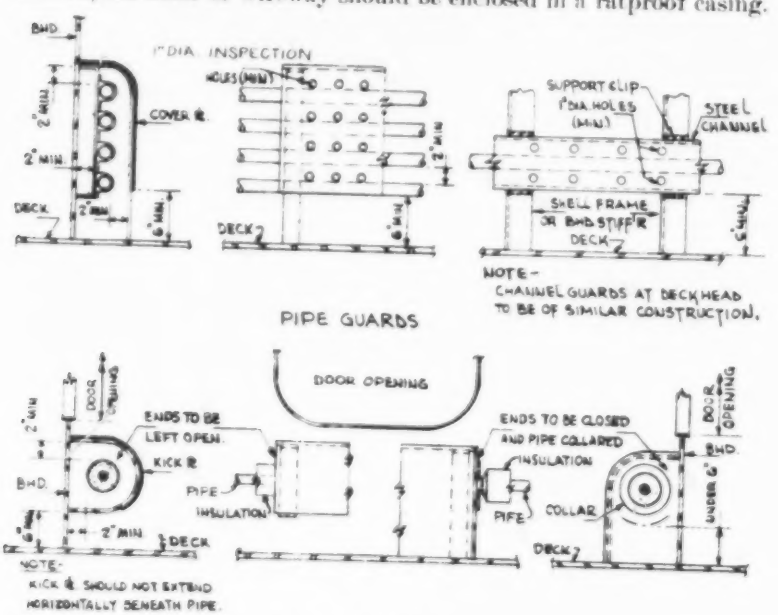
Figure 37

located, and should be provided with sufficient lightening holes to overcome these objections.

Semicircular, channel, and angle-type guards, when in a horizontal position, should be toed down and so placed as to hide no surface which might serve as a rat runway. Channels and angles in a horizontal position should not be toed up, unless the ledge created by the lower flange is readily visible. Channels should not be used where they hide the upper surface of, or space between, horizontal pipes, cables and similar appurtenances.

Protective covers for heating pipes or coils, and for kickplates in way of doors, should not extend to the deck, nor horizontally beneath the pipe or coil. It is preferable that protective covers for pipe terminate at least 6 inches above the deck, and that they be open at both ends. If complete enclosure is necessary, there should be no holes in the casing larger than one-half inch (see fig. 38).

21. WIREWAY AND CABLE GUARDS. Wireway and cable guards of the metal-bar type are preferable, from a ratproofing standpoint. They should be installed wherever the location of the cable or wireway is such as to create no rat harborage and does not prevent the inspection of the top of the wireway. In places where harborage is created, the cable or wireway should be enclosed in a ratproof casing.



PROTECTION GUARDS FOR SERVICE FACILITIES

Figure 38

Bar-type guards should be constructed of bars not over 2 inches in width, which are so placed as to have a clearance between bars of 2 to 4 inches. In no case should the clearance between bars at the side be less than 1½ inches. The cables should be so placed that the top of each layer is opposite the top of a bar. The cables should be in groups, preferably not more than 8 inches wide, with an opening of at least 2 inches between groups. The slots thus created should be above each other where there are several layers of cables, and the bars which form the underside of the wireway guard should not be below these slots (see fig. 39).

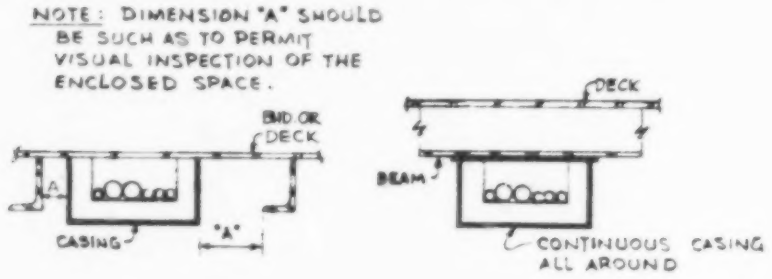
Casing-type wireway or cable guards should be of adequate strength, and of material suitable to the space in which installed. Metal casings are preferred, but nonratproof materials are suitable, in passageways and similar spaces.

Wireway casings should consist of portable sections. The weight and size of each section, and the method of attachments, should be such as to facilitate removal and replacement.

Casings should extend continuously through ratproof boundaries or double bulkheads; otherwise, the openings in these bulkheads, through which the cables pass, should be ratproofed.

Cable and wireway casings and junction boxes should be placed at least 6 inches above the finished deck, or the space should be ratproofed.

At the deckhead, wireway casings which are parallel to the beams should be placed as recommended for ventilating and heating ducts in item 25. Those casings which are below, and run transversely to, the deckhead beams should terminate at the lower surface of the deckhead beams, and should not extend into the space between beams.



NOTE - THOUGH OPEN TYPE CONSTRUCTION IS PREFERRED VERTICAL CHANNEL GUARDS WITHOUT INSPECTION HOLES MAY BE INSTALLED PROVIDING NO RAT HARBORAGE IS CREATED

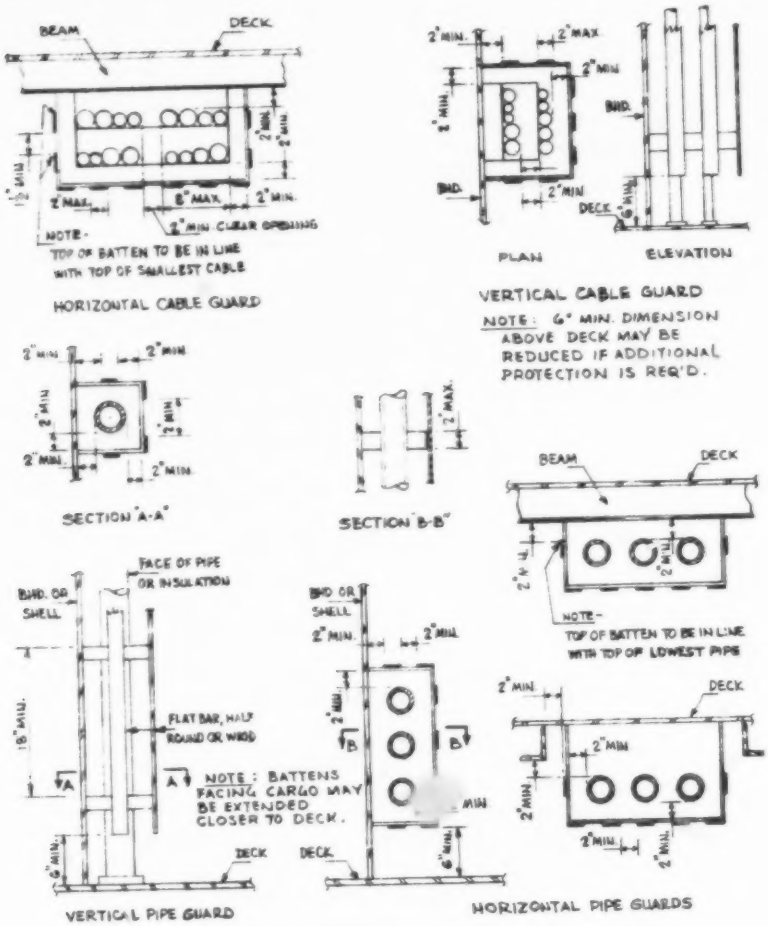
CASINGS FOR WIREWAYS

Figure 39

Cables should enter casings through nipples or stuffing tubes. Sheet metal collars should be installed at such penetrations of expanded metal if there are openings greater than one-half inch.

SERVICE FACILITIES—INSTALLATIONS

22. GENERAL. Service lines should be installed in such a manner as to avoid creating rat harborages and spaces which cannot be inspected and cleaned.



PROTECTION GUARDS FOR SERVICE FACILITIES

Figure 40

Most service-line installations should be left open. Where uninspectable areas are created, the need for ratproofing will have to be determined with due consideration of such factors as the amount of light above the service lines, the space existing between them, and whether or not any of the lines or adjacent fixtures are insulated.

When ratproofing is necessary, service lines should be completely encased. When enclosures are necessary in passageways, the facilities should be placed high enough to permit the installation of portable inspection panels.

CEILINGS IN RATPROOF AREAS

All penetrations (by pipes, cables, wireway, and duct(s) of bulkheads, decks, deckheads, and partitions which form the boundaries of ratproof spaces, should be ratproof. Criteria for maximum openings, as defined, should be followed (see fig. 17, 46, and 48).

23. PIPES. All exposed pipes, except in propelling and auxiliary machinery spaces, should be installed away from corners, stiffeners, bulkheads, bosoms of beams, brackets, and similar fixtures. They should be kept sufficiently spaced with respect to one another to permit easy inspection. At least 2 inches should exist between pipes, and between a pipe and any surface that parallels it (see fig. 40).

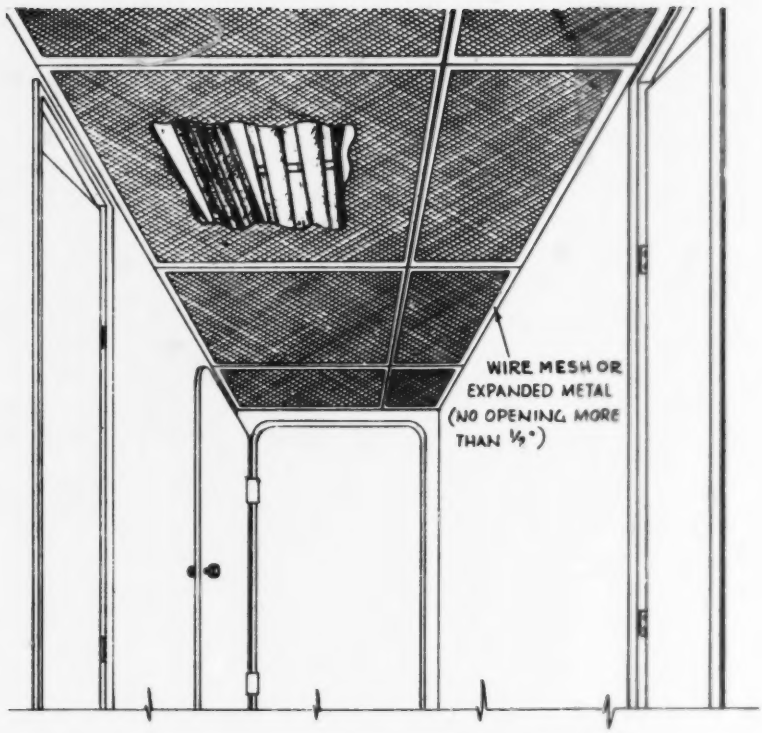
When it is necessary to place pipes in contact with one another in horizontal layers, the grouping should be limited to 8 inches in width, with 2 inches between groups. When these provisions are impracticable, and uninspectable surfaces and rat harborages are created, enclosure is required.

Horizontal pipes should be kept at least 6 inches from the deck or tank-top, and a sufficient distance from bulkheads, sheathing, and structures on deck to prevent creation of an uninspectable space.

24. CABLES—ELECTRIC, TELEGRAPHIC, AND MECHANICAL. Cables in groups should be attached directly to bulkheads or deckheads, or within one-half inch of them, wherever practicable. The grouping should be limited to 8 inches in width, and there should be a space of at least 2 inches between groups. When cables are installed and not encased, the backing plates to which the cables are attached should be not more than 8 inches wide, with a 2-inch space between parallel plates (see fig. 43).

When an open, inspectable type of cable installation is impossible and a rat harborage is created, the cables should be enclosed.

Cables should pass through stuffing tubes, thimbles, or nipples wherever they penetrate bulkheads, deckheads, and partitions, or enter closed wireway guards and pull-, fuse-, or switch-boxes. Direct penetrations of metal surfaces by individual cables should be ratproofed.

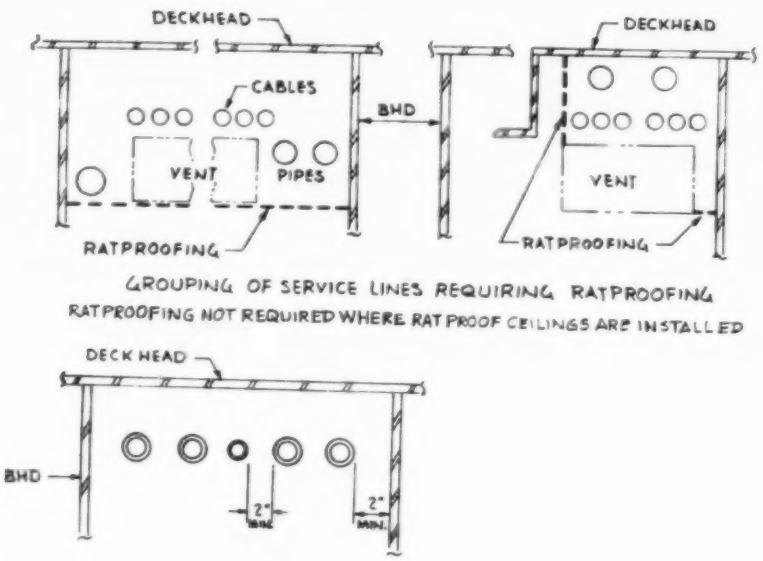


CEILING IN RATPROOF AREAS

Figure 41

When sheet-iron collars are installed, they should fit to within one-fourth inch of the outer surface of the individual cable or group of cables. When placed around a wireway, the inner edge of the collar should be cut to conform to the outer surface of the wireway. A strip of sheet lead can be placed around the cable or wireway, as a safeguard against the insulation being cut by the collar. Placing the two halves of the collar tightly against the cables will prevent vibration and cutting (see fig. 20).

A heavy flange on a stuffing box, a washer behind a nut, or the nut of a nipple, if covering the gnawing edge of a penetration of hard composition material at least one-fourth inch, will provide satisfactory protection in lieu of a sheet-metal collar.



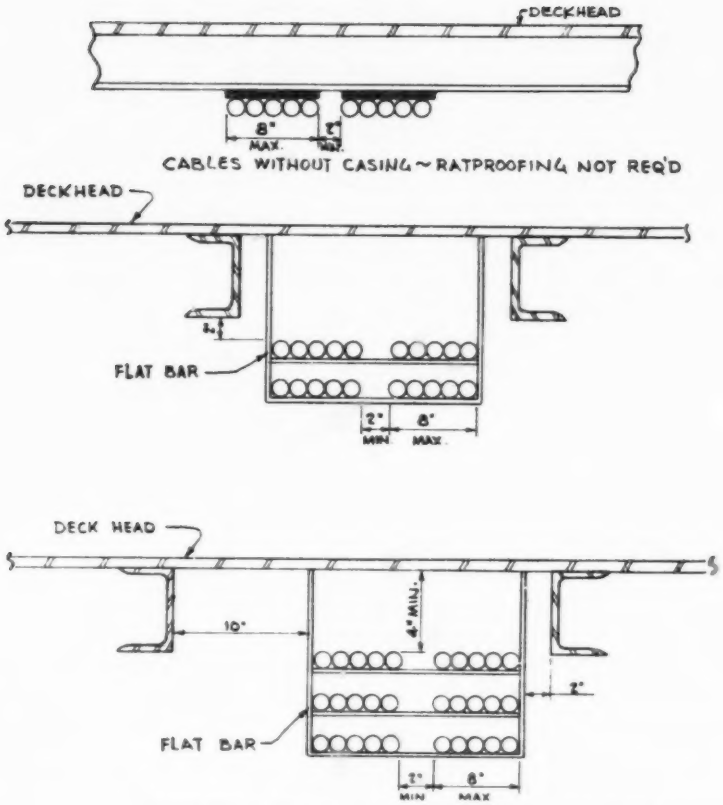
TYPICAL INSTALLATIONS OF SERVICE FACILITIES

Figure 42

25. VENTILATING, AIR-COOLING, AIR-CONDITIONING, AND HEATING SYSTEMS. Mushroom and torpedo ventilators in the superstructure and deckhouses should be continuous when passing through double bulkheads or deckheads. Where necessary, the sleeve of the ventilator should be extended by the addition of sheet metal. Penetrations of nonratproof bulkheads, deckheads, or sheathing should be collared.

Air ducts should be so constructed and located that rat harborages will not be created. They should be continuous when passing through double bulkheads and insulation. Nonratproof materials are suitable for certain spaces other than general-cargo holds, provided that all gnawing edges are flashed. Air ducts which traverse the void space within double bulkheads or deckheads should be ratproof.

Rectangular air ducts should be installed either tightly against, or entirely away from, deckheads and bulkheads, to permit inspection. If not flush with the deckhead plating, the duct should be sufficiently below the deckhead beams to permit inspection of the top, but in no case less than 2 inches when the duct runs parallel with the deck supports. In some spaces, it may be necessary to place the ducts between



NOTE: RATPROOF CLEARANCES NOT APPLICABLE WHERE RATPROOFED CEILINGS ARE INSTALLED.

TYPICAL INSTALLATIONS OF SERVICE FACILITIES

Figure 43

beams, but not flush with the deckhead. With this arrangement, the space on the side should be at least 10 inches wide, and the spaces above the casing at least 3 to 4 inches, in order to permit inspection (see fig. 43).

Spaces made uninspectable by the arrangement of ventilating or heating ducts should be completely enclosed with sheet metal, or the need for ratproofing will have to be determined with due consideration of such factors as the amount of light above the service lines, the space existing between them, and whether or not any of the lines or adjacent fixtures are insulated. Expanded metal or wire cloth is suitable in lieu of sheet metal, except in cargo spaces (see fig. 42).

26. SCREENING OF VENT OPENINGS. Intakes, exhausts, and outlets should be protected by ratproof screening, unless the opening is equipped with a louver in which no slot or hole is greater than one-half inch. Insect screening is not satisfactory as ratproofing (see app. A).

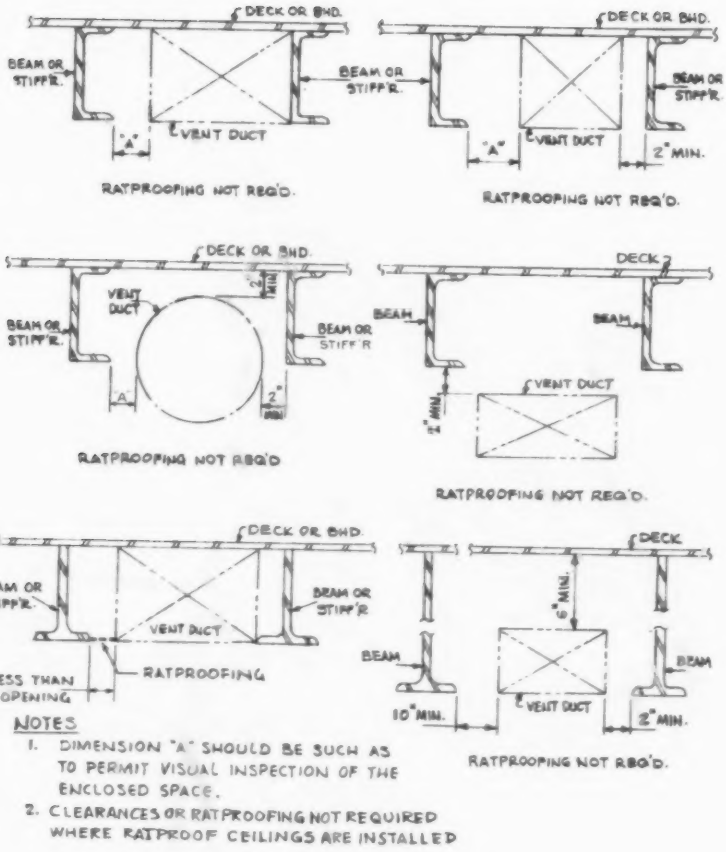
All gravity and forced-draft intake and exhaust openings should be ratproofed. Ventilation facilities serving a single space need be ratproofed only on that end which is most effective in preventing harborage for rats and debris, unless a rat harborage is created by a horizontal run of duct. Ducts extending from the weather deck directly to the cargo holds, engine room, and boiler rooms, with no horizontal extensions, need not be ratproofed at either end. Ventilation terminal openings in living quarters, dining rooms, and other public spaces need not be ratproofed, provided that they are located in the deckhead near the center of the space, and that there are no avenues of approach and little likelihood of one being provided.

Ventilating hoods and canopies should terminate flush with the deckhead and should be screened as specified above. Pipes, cables, air ducts, and similar features over tops of hoods should be grouped so as not to form spaces or pockets which will be inaccessible for inspection. If such spaces are formed, they should be completely closed with sheet metal of 18- or 22-gauge, according to the ratproof area involved.

INSULATION

27. GENERAL. Rats have been observed to burrow through, and harbor and raise young in insulation commonly used on vessels. Insulation of 1 inch, or less, in thickness which is in direct contact with the surface being insulated need not be ratproofed. Insulation over 1 inch in thickness should be sheathed with an approved ratproof material (see fig. 45).

Expanded metal will be satisfactory as sheathing of insulation in spaces other than galleys and pantries. The expanded metal should



NOTES

1. DIMENSION "A" SHOULD BE SUCH AS TO PERMIT VISUAL INSPECTION OF THE ENCLOSED SPACE.
2. CLEARANCES OR RATPROOFING NOT REQUIRED WHERE RATPROOF CEILINGS ARE INSTALLED

TYPICAL INSTALLATIONS OF SERVICE FACILITIES

Figure 44

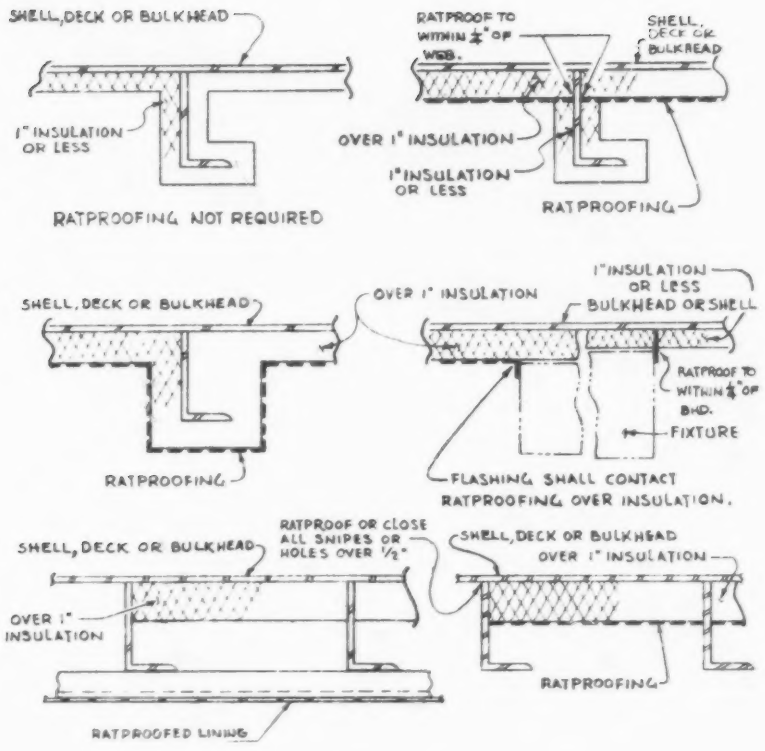


Figure 45

extend to within one-half inch of structural plates, or should join other ratproofing material. When expanded metal is to be covered with a plaster coat, the plaster should not be applied until the expanded metal has been inspected.

28. GENERAL-CARGO HOLDS. Where insulation in general-cargo spaces is to be covered with metal, 16-gauge sheet metal should be placed directly on the insulation. At the deckhead, at least 18-gauge sheet metal should be used. When special protection is necessary a heavier-gauge material is recommended.

Wooden screen bulkheads in cargo holds must be ratproofed when there is space with or without insulation, greater than three-fourths inch between a steel plate and the wooden screen bulkheads. If 2⅝-inch-thick tongue-and-groove or shiplap planking is used, only the butt ends and corners need be flashed with at least 16-gauge sheet metal. If butt joint planking is used, each joint end, and corner should be

flashed with at least 16-gauge sheet metal. All penetrations of wooden screen bulkheads should be collared with at least 16-gauge sheet metal. An exception to this requirement is covered in item 5, paragraph 2.

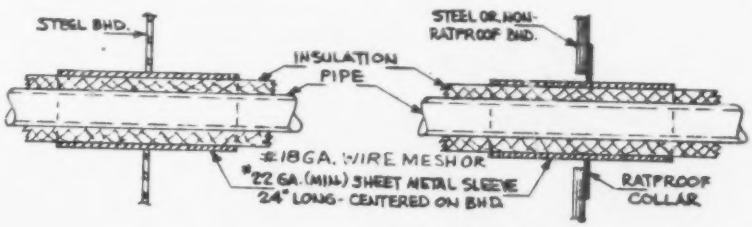
29. REFRIGERATED-CARGO SPACES. Insulation within refrigerated-cargo spaces should be ratproofed by complete coverage with sheet metal or acceptable nonratproof material.

30. REFRIGERATING-MACHINERY SPACE. Insulation on machinery, pipe, pipe manifolds, valve cabinets, and similar appurtenances within refrigerating machinery spaces are exempt from ratproofing, provided that the boundary bulkheads and deckhead, the sheathing over voids or insulation therein, and the penetrations of bulkheads and the deckheads are ratproofed, and the door is conspicuously labeled KEEP CLOSED.

31. ENGINE AND MACHINERY CASING. Insulation on machinery, pipe, pipe manifolds, valve cabinets, and similar appurtenances within engine and boiler room machinery casings need not be ratproofed.

32. GALLEY, PANTRY, AND FOOD STOREROOMS. Insulation on the galley, pantry, and food storerooms' deckheads and bulkheads should be sheathed with metal or some other hard, smooth-surfaced material (see section E, item 2).

33. SLEEVES. Sleeves or stuffing tubes should be installed around insulated pipes or service lines which pass through double bulkheads and deckheads of refrigerated spaces. The sleeve or stuffing tube should be of a ratproof material and should extend for a distance of 12 inches on both sides of each penetration (see fig. 46). When the penetrated bulkhead is of an acceptable nonratproof material, a sheet metal collar should be placed around the sleeve or stuffing tube at the outer surface of each bulkhead penetration. When the bulkhead penetrated is of metal, the annular space in the bulkhead around the



PIPE WITH OVER ½" INSULATION
CONTINUOUS THROUGH BHD.

BULKHEAD PENETRATIONS

Figure 46

penetrating sleeve or stuffing tube should be no wider than one-fourth of an inch.

34. PIPES. Pipe and pipe fittings which carry brine or other refrigerants, and which are covered with hairfelt or similar insulation of 2 inches or less in thickness, need not be ratproofed. For insulation which is thicker than 2 inches, the need for ratproofing will be judged on the basis of arrangement and location.

Other pipes insulated with hairfelt or similar material thicker than 1 inch should be ratproofed, unless the pipe is within a ratproof void or a rat-tight area.

The need for ratproofing cork insulation (regardless of thickness) around pipes, including those carrying refrigerants, will be judged on the basis of arrangement and location.

All insulated pipes should be wrapped separately, and should be so spaced as to allow at least 2 inches between wrappings, if practicable. Where two or more pipes are insulated and wrapped together, or insulated separately and enclosed in one wrapper, the need for ratproofing should be judged on the basis of arrangement and location.

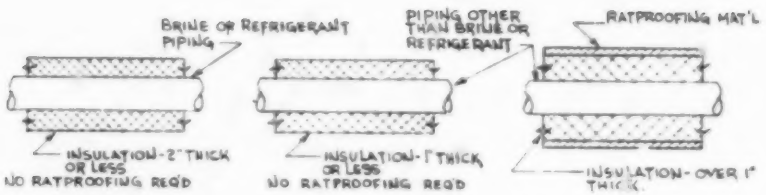
When ratproofing is necessary, it should consist of sheathing the pipe or pipes with at least 24-gauge sheet metal or 18- to 20-gauge hardware cloth. The wire cloth should be applied beneath the wrapping, and may be embedded in the insulation not more than 1 inch from its outer surface. All penetrations of acceptable nonratproof material by insulated pipe should be collared (see fig. 47).

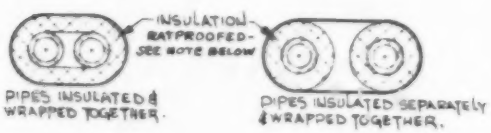
The requirements for plastic pipe with insulation 1 inch in thickness or greater are the same as for metal piping.

35. VENTILATING, AIR-CONDITIONING, AND HEATING DUCTS. Hairfelt or similar insulation which is less than 1 inch thick, over ventilating, air-conditioning, and heating ducts, need not be ratproofed. For insulation over 1 inch thick, ratproofing will be necessary, except in rat-tight areas (see fig. 48). When cork is used, the need for ratproofing will be judged on the basis of arrangement and location.

No ratproofing will be necessary in the case of vent ducts which are located within double bulkheads or deckheads which are ratproof, or in fan rooms which have ratproof boundaries and whose doors are marked KEEP CLOSED. Ratproofing, if necessary, should consist of complete coverage with 24-gauge metal, 18- to 20-gauge steel-wire or hardware cloth, 20-gauge expanded metal, 20- to 22-gauge flattened expanded metal, or 3.4-pounds-per-square-yard metal lath with an acceptable hard-plaster coating. The ratproofing material should be placed over the insulation and beneath any covering.

In cargo spaces, the ratproofing material should be at least the next-heavier even-numbered gauge.


BRINE OR REFRIGERANT PIPING
PIPING OTHER THAN BRINE OR REFRIGERANT
RATPROOFING MAT'L
INSULATION - 2" THICK OR LESS
NO RATPROOFING REQ'D
INSULATION - 1" THICK OR LESS
NO RATPROOFING REQ'D
INSULATION - OVER 1" THICK.


INSULATION - RATPROOFED - SEE NOTE BELOW
PIPES INSULATED & WRAPPED TOGETHER.
PIPES INSULATED SEPARATELY & WRAPPED TOGETHER.

PIPING INSULATION DETAILS
IN CARGO HOLDS

NOTE -
WHEN WIRE CLOTH IS USED FOR RATPROOFING PIPE INSULATION, IT MAY BE APPLIED BENEATH THE WRAPPING; AND MAY BE IMBEDDED IN THE INSULATION NOT MORE THAN 1" FROM THE OUTER SURFACE OF THE INSULATION.

INSULATION

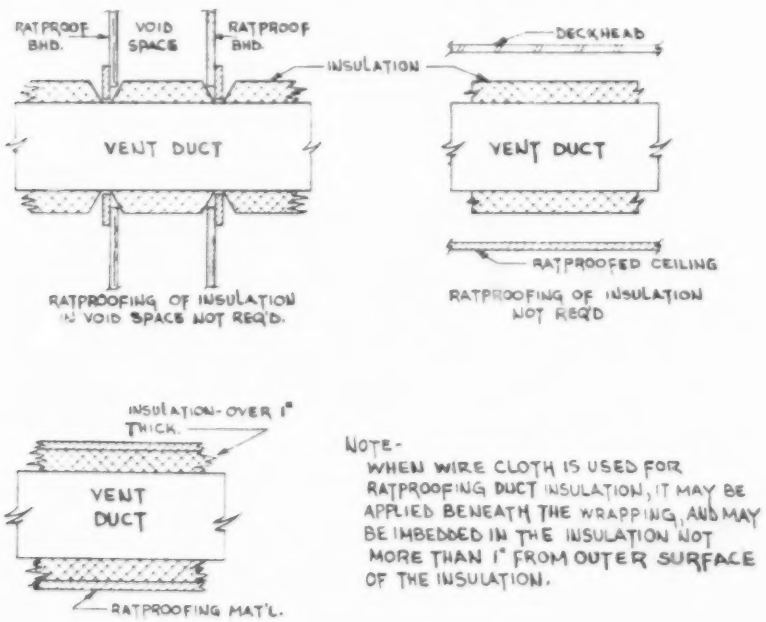
Figure 47

DECK MACHINERY AND EQUIPMENT

36. GENERAL. Deck machinery and equipment (and the foundations thereof) should be so constructed or ratproofed as to provide no temporary hiding place or permanent harborage for a rat. It is preferable that open-type construction be employed. All spaces to which a rat might gain entrance should be sufficiently open to admit light and to facilitate inspection and cleaning. Where open construction is impracticable, the space should be closed, with no holes greater than one-half inch. Closure should be effected with at least 16-gauge sheet metal, 13-gauge expanded metal, 13- to 15-gauge flattened expanded metal, etc. (see app. A).

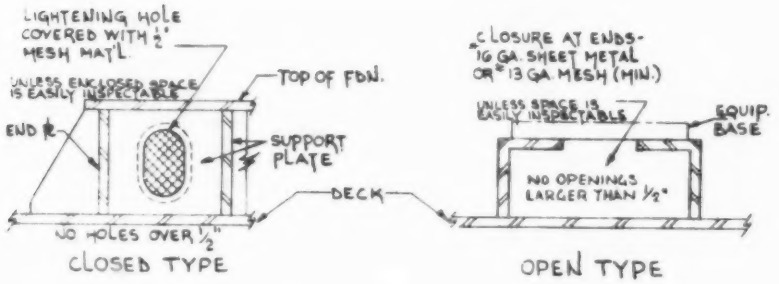
When the space within the foundation or beneath a solid base or cover plate can be viewed from opposite sides, the height of the space should be sufficient to permit easy inspection. When it is less than 6 inches, creating a rat harborage, the space should be closed (see fig. 49).

37. ROPE AND CABLE REELS. Rope and cable reels should be of metal construction, and should be installed on open-type metal supports. The center core should be of solid or perforated metal. Hol-

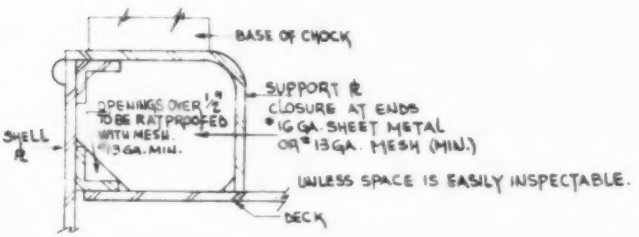

RATPROOF BHD.
VOID SPACE
RATPROOF BHD.
INSULATION
VENT DUCT
RATPROOFING OF INSULATION IN VOID SPACE NOT REQ'D.
DECKHEAD
INSULATION
VENT DUCT
RATPROOFED CEILING
RATPROOFING OF INSULATION NOT REQ'D
INSULATION-OVER 1" THICK.
VENT DUCT
RATPROOFING MAT'L.
NOTE-
WHEN WIRE CLOTH IS USED FOR RATPROOFING DUCT INSULATION, IT MAY BE APPLIED BENEATH THE WRAPPING, AND MAY BE IMBEDDED IN THE INSULATION NOT MORE THAN 1" FROM OUTER SURFACE OF THE INSULATION.

INSULATION

Figure 48


LIGHTENING HOLE COVERED WITH ½" MESH MAT'L
UNLESS ENCLOSED SPACE IS EASILY INSPECTABLE
TOP OF FDN.
END ℄
SUPPORT PLATE
DECK
NO HOLES OVER ½"
CLOSED TYPE
℄ CLOSURE AT ENDS- 16 GA. SHEET METAL OR* 13 GA MESH (MIN.)
UNLESS SPACE IS EASILY INSPECTABLE
EQUIP. BASE
NO OPENINGS LARGER THAN ½"
OPEN TYPE

FOUNDATIONS FOR WEATHER DECK MACH'Y


BASE OF CHOCK
SUPPORT ℄
CLOSURE AT ENDS
*16 GA. SHEET METAL
OR* 13 GA. MESH (MIN.)
OPENINGS OVER ½" TO BE RAT PROOFED WITH MESH. *13 GA. MIN.
SHELL ℄
UNLESS SPACE IS EASILY INSPECTABLE.
DECK

FOUNDATION FOR MOORING CHOCK

FOUNDATIONS

Figure 49

low axles having a diameter greater than 1 inch should be plugged, unless the area is inspectable.

38. MOORING FITTINGS. Bitts, chocks, cleats, and other mooring fittings should be either open for inspection or completely closed. Any rat harborage within or adjoining such fittings should be ratproofed with heavy ratproofing material. Holes in castings greater than one-half inch, such as are sometimes found in crucifix bitts, should be sealed with metal.

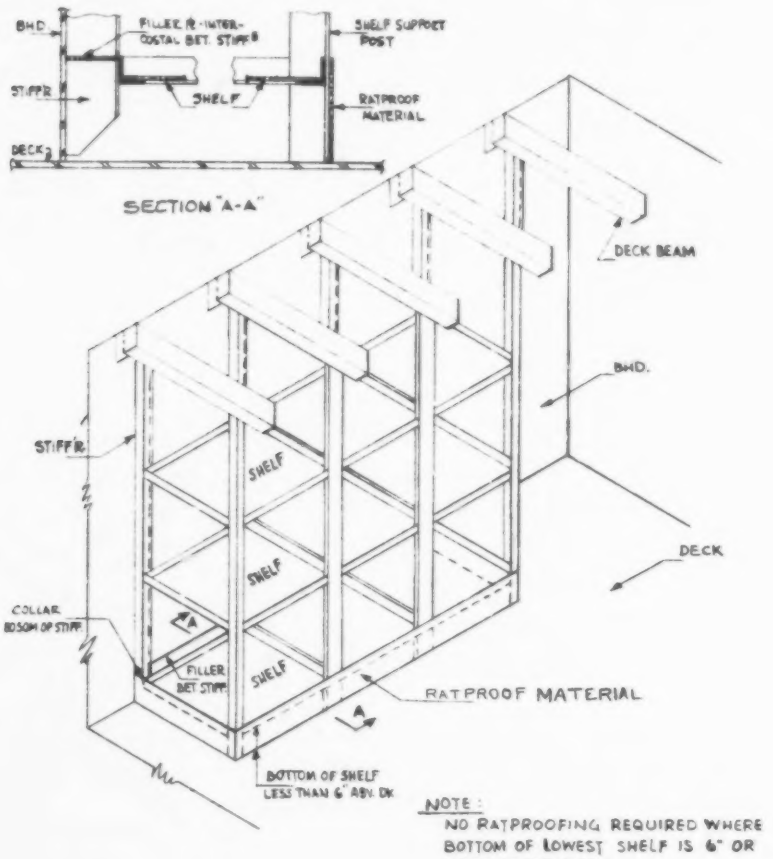
STOWAGE-SPACE FACILITIES

39. SHELVES. Shelves or platforms should be so installed as to avoid the creation of pockets or hidden places. When such places are unavoidable, they should be enclosed with sheet metal of at least

22-gauge. Shelves and platforms used for the storage of foods should preferably be constructed of sheet metal (see fig. 50).

40. BINS. Bins should be placed either flush against, or well away from bulkheads and structural members. If not flush with the deck, the space underneath should be ratproofed with at least 22-gauge sheet metal. All bins should have tight-fitting covers, preferably of the self-closing type.

41. SPARE-PARTS BOXES. Large spare parts, such as propellers, propeller blades, and shaft sleeves, should be stowed in a ratproof manner. From a ratproofing standpoint, they should not be encased. When this is not possible, and when the casing is of nonratproof



SHELVING

Figure 50

material, ratproofing will be necessary, unless the parts are stowed in a ratproof compartment.

Small spare-parts boxes should be made of metal, unless they are to be stowed in a ratproof compartment.

42. LOCKERS. All lockers should be installed in such a manner as to form no rat harborages at the deck or deckhead or with adjacent structures. If not placed flush with the deck, the locker should be elevated at least 6 inches or the space closed with sheet metal of at least 22-gauge.

The boundaries of a locker in way of a void space created by a fixed false bottom should be made ratproof or rat-tight according to the area.

In spaces other than ratproof or rat-tight areas, the lockers should be fabricated of metal. They may be of wood or other acceptable nonratproof material provided they are properly lined or flashed with at least 22-gauge sheet metal. The edges of lockers made of wire cloth or expanded metal should be bound with at least 22-gauge sheet metal.

43. BOXES. Weather deck boxes should preferably be made of metal. If of wood, they should be made ratproof by lining the entire bottom and the lowest 1½ inches of the sides with at least 22-gauge sheet metal or 18-gauge wire mesh. Other exposed edges of such boxes should be properly flashed.

Storeroom boxes or boxes placed in other ratproof areas shoud be made rat-tight.

FURNITURE AND FIXTURES

44. GENERAL. Furniture including wardrobes, should preferably be made of metal. Ratproofing will not be required of wooden furniture which has no openings greater than one-half inch, and which affords complete visibility of the interior of the base by such means as the removal of drawers or loose false bottoms. Wherever the interior of the base is not visible because of a complete or partial fixed bottom, or because a drawer cannot be removed, the gnawing edges should be protected.

Whenever possible, furniture and fixtures shoud be installed flush with the deck or elevated at least 6 inches. Partially enclosed spaces around furniture should be closed with 22-gauge or heavier sheet metal.

45. GALLEY FIXTURES. Fixtures in galleys should be so designed and located as to afford neither harborage for rats nor places for the accumulation of food. All galley fixtures should be of metal, and all seams therein should be fitted closely and, preferably, welded or soldered. If galley fixtures are designed, constructed and installed in

compliance with the criteria included in sections E and F of this book, they will also be satisfactory from the ratproofing standpoint.

46. ELECTRIC REFRIGERATORS, DRINKING FOUNTAINS, AND DRINKING-WATER COOLERS. The machinery compartment should be enclosed with 16-gauge wire cloth or 18-gauge expanded metal, or equipped with ½-inch louvers. Where holes are cut in the mesh for the passage of waterpipes or electric cables, metal collars should be provided. Doors of machinery compartments should be tight-fitting on all sides.

APPENDIX A

Minimum Thickness—Approved Ratproof Material

Item	Solid sheet steel	One-half-inch maximum openings			Figure No.
		Raised expanded metal	Flattened expanded metal	Wire or hardware cloth	
GENERAL-CARGO HOLDS	*Gauge*	*Gauge*	*Gauge*	*Gauge*	
Sheathing on bulkheads	16				
Sheathing on deckheads	18				
Battens at tonnage openings	16				37
Collar plates at penetrations	16				20, 21, 46
Sheathing over permanent ballast	16				35
Covers for access manhole wells at permanent ballast	16				36
Covers or guards for manholes	22				36
Insulation (except at piping and vent ducts)	16	16	16–18		45
Insulation over 1 inch at piping	22			16–18	46
Insulation over 1 inch at vent ducts	22	18	18–20	16–18	48
Voids and pockets	16	[1] 12	12–14	11	28, 29, 30, 34
REFRIGERATED-CARGO HOLDS					
Sheathing—with battens	22	[2] 18	[2] 18–20		
Sheathing—without battens	18	[2] 14	[2] 14–16		
Collar plates at penetrations	18				
Covers or guards for manholes	22				
External corners	18				
Internal corners	22				
Insulated stanchions	11				
Flooring		18	18–20	18	26
Insulation over 1 inch	18	18	18–20		45
Battens					37
REFRIGERATED STORES					
Sheathing	22	[2] 18	[2] 18–20		
Doors	22				33
Door casings—outside surface	22				33
Door casings—inside surface	22			18	33
Shelving voids	22	18	18–20	14	50
Collar plates at penetrations	22				20, 21, 46
Flooring		18	18–20	18	26
Covers or guards for manholes	22				36
Insulation over 1 inch	18	18	18–20		45
Voids and pockets	18	18	18–20	14	
STOREROOMS					
Sheathing	18				
Shelving voids	18	18	18–20	14	50
Collar plates at penetrations	22				20, 21, 46
Doors	22				27
Flooring	18	18	18–20	14	26
Voids and pockets	18	18	18–20	14	
COMMISSARY SPACES					
Sheathing	22				
Shelving voids	22				50
Collar plates at penetrations	22				20, 21, 46
Flooring	22	18	18–20	14	26
Insulation over 1 inch	22				45
Voids and pockets	22	18	18–20	14	
Foundations	18				
Flashing internal corners	22				
Flashing external corners	18				
Skylights				18	

[1] Or perforated sheet steel.
[2] Hard finished composition coating required.

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Item	Solid sheet steel	One-half-inch maximum openings			Figure No.
		Raised expanded metal	Flattened expanded metal	Wire or hardware cloth	
RAT-TIGHT AREAS (To close openings greater than one-half inch)	*Gauge*	*Gauge*	*Gauge*	*Gauge*	
Sheathing	22	18	18–20	16	
Collar plates at penetrations	22				
Voids and pockets	22	18	18–20	16	
AIR INTAKE, EXHAUSTS AND OUTLETS					
General cargo holds		[1] 16	16–18	14	
Refrigerated cargo holds		[1] 16	16–18	14	
Elsewhere—interior		[1] 16	16–18	14	
Elsewhere—exposed to weather		[1] 13	13–15	13	
MISCELLANEOUS					
Furniture and fixture voids	22	18	18–20	16	
Machinery foundations on weather decks	16	[1] 13	13–15		47
Machinery compartments interior ratproof areas		[1] 18	18–20	16	
Lockers—interior	22			18	
Lockers—exterior	20			16	

[1] Or perforated sheet metal.

APPENDIX B

Minimum Thickness—Acceptable Nonratproof Material

Location	Wood		Resin-bonded water-proof plywood	Typical composition materials			
	Tongue and groove or shiplap	Square butt joint		Rigid asbestos cement panel	Flexible asbestos cement sheet	Metal-lami-nated asbestos cement sheet	Faced asbestos insulating panel
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Refrigerated-cargo holds	[1] 1½		[1] 1	[2] 3/8		[3] ¼	
				[4] ½		[5] ¼	
Ship's stores refrigerated spaces	[6] 1½		[6] 1	[7] 3/8		3/16	
				[8] ½			
Storerooms	¾		¾	½			⅛
Commissary spaces				3/8	[9] 3/16		¾
Living and public spaces, fan, radio and gyro rooms	¾		½	¾	3/16		[10] ¾
Permanent ballast	2⅜	2⅜					
Shaft alley ceiling	2						
Bilge ceiling	2⅜	2⅜					
Wooden sheating over insulation	2⅜	2⅜					

[1] Two layers acceptable or combination of tongue and groove or shiplap and plywood totaling 1⅜ inches also acceptable.
[2] With batten protection.
[3] Steel.
[4] Without batten protection.
[5] Aluminum.
[6] A combination of tongue and groove or shiplap and plywood totaling 1 inch also acceptable.
[7] Bulkheads.
[8] Deckheads.
[9] Solid—on deckhead.
[10] Panel need not be faced.